Protection by Face Masks against H1N1 Virus on Trans-Pacific Passenger Aircraft, 2009

[Announcer] This program is presented by the Centers for Disease Control and Prevention.

After H1N1 virus was identified in April 2009, it spread rapidly, largely through air travel by infected passengers. On May 2, 2009, China implemented intensive screening of arriving air passengers by using thermal cameras to detect fever and a short questionnaire about existing respiratory symptoms and fever; passengers were advised to seek medical consultation if fever or respiratory symptoms developed within seven days of arrival. Nasopharyngeal swab specimens collected from all arriving febrile passengers were tested for virus at the nearest Centers for Disease Control, or CDC, laboratory by using real-time reverse transcription PCR. If any of these results were positive results, all passengers on the same flight were quarantined.

On May 11, 2009, this system detected the first confirmed H1N1 infection in mainland China in a U.S. traveler. As of May 29, the system detected 21 other imported infections in passengers arriving on international flights. On May 29, the first locally acquired H1N1 infection was detected.

On May 30, acute onset of fever, cough, sore throat, and headache developed in a 22-year-old man. He sought treatment at a clinic in Fuzhou, China, where medical staff learned that he recently arrived from New York, USA, and reported a suspected case of H1N1 infection to the county CDC. On May 31, duplicate nasopharyngeal swab specimens from the patient were positive for H1N1 virus at Fuzhou CDC and the Fujian Provincial CDC.

On May 27 at 10:40 am, the patient had departed New York on a flight to Hong Kong, China. After flying for 5 hours and 50 min, the plane made a scheduled stopover in Vancouver, British Columbia, Canada. All passengers remained on board during the stopover, which lasted 1 hour and 15 minutes. Air-handling systems were fully operational. The aircraft left Vancouver and flew for 13 hours and 15 minutes and arrived in Hong Kong at 7:00 am on May 28. In Hong Kong, 63 passengers transferred to a Hong Kong to Fuzhou flight which departed Hong Kong at 8:50 am and arrived at in Fuzhou City Airport at 10:30 am.

The aforementioned patient had no fever or respiratory symptoms when screened on arrival at Fuzhou. The Fujian Provincial CDC, concerned that other passengers on the Hong Kong to Fuzhou flight might be infected, traced and quarantined the arriving passengers and crew members in their own homes, designated hotels, or hospitals. According to Chinese Ministry of Health guidelines, social contacts of this confirmed case-patient were traced and quarantined. These passengers, crew members, and contacts were monitored for seven days for fever and respiratory illness; nasopharyngeal swab specimens were obtained from symptomatic persons. This effort identified seven additional case-passengers on the Hong Kong to Fuzhou flight in whom symptoms developed during May 30–June 1 and had H1N1 infection confirmed by Real Time-PCR. All eight case-passengers had arrived in Hong Kong on the same New York to Hong Kong flight. The China CDC and the Fujian Provincial CDC initiated an outbreak investigation to assess possible transmission of H1N1 virus on those flights and better understand risks for influenza spread in confined settings.

Methods

Case Definition

We defined a suspected case of H1N1 infection as an acute, febrile, respiratory illness with onset during May 21–June 4, 2009, among passengers or crew members on the New York to Hong Kong flight on May 27 or the Hong Kong to Fuzhou flight on May 28. A confirmed case was a suspected case with laboratory evidence of H1N1 infection by PCR testing of respiratory specimens. We defined influenza-like illness, or ILI, as acute onset of fever greater than or equal to 37.5 degrees Centigrade and cough or sore throat.

Retrospective Investigation

From the Fuzhou airport quarantine post, we obtained a list of passengers who had arrived in Fuzhou on the Hong Kong to Fuzhou flight. All passengers had been quarantined for seven days at home or in designated hotels or hospitals. Body temperatures were measured daily; if fever or respiratory symptoms developed in passengers, a nasopharyngeal swab specimen was obtained and tested for H1N1 by using REAL TIME-PCR. Health professionals at the Centre for Health Protection, Department of Health, Hong Kong, attempted to contact all passengers on the New York to Hong Kong flight who had disembarked in Hong Kong.

Case–Control Study

To assess risk factors for transmission of H1N1 on the New York to Hong Kong flight, we conducted a case–control study. We compared exposure history and other risk factors of nine confirmed case-passengers with those of 32 control-passengers in the economy-class cabin. We attempted to contact 55 noninfected passengers who disembarked in Fuzhou and 18 noninfected passengers who disembarked in Hong Kong, and we interviewed all persons greater than five years of age who agreed to be interviewed. Crew members and business-class passengers were excluded. A total of 32 noninfected passengers provided complete information and served as controls. Of these 32 control-passengers, 28 boarded in New York, 27 disembarked in Fuzhou, and one disembarked in Hong Kong; and four boarded in Vancouver and disembarked in Hong Kong.

We conducted face-to-face interviews with case- and control-passengers bound for Fuzhou at hospitals or hotel rooms where they were quarantined. For passengers quarantined at home or who disembarked in Hong Kong, including one case-passenger in Hong Kong, interviews were conducted by telephone. Using a standard questionnaire, we interviewed case- and control-passengers on factors potentially affecting the likelihood of H1N1 virus infection during the seven days before and during the flight. These factors included contact with ILI patients less than or equal to one week before the flight, moving around the airplane during the flight, lavatory use, handwashing, face mask use, or wearing a face mask, for how long, and when they wore it and did not wear it, and talking with other passengers.

Laboratory Testing

Respiratory specimens, such as nasal, throat, and nasopharyngeal swab specimens and nasopharyngeal aspirates, were collected from suspected case-passengers and persons being quarantined in whom fever or respiratory symptoms developed.

Results

Outbreak Description

Of 144 persons on the Hong Kong to Fuzhou flight, follow-up and quarantine measures were completed for 140. Eight had confirmed H1N1 infections; all eight had ILI. Four additional febrile passengers did not have respiratory symptoms and were negative for H1N1 virus. In addition, three of 40 social contacts of case-passengers had ILI; two had confirmed H1N1 infections. All eight confirmed case-passengers with H1N1 infections were among 63 passengers who had transferred from the New York to Hong Kong flight, compared with none among 73 other passengers who boarded in Hong Kong or among the eight crew members. The investigation focused on the New York to Hong Kong flight. All nine case-passengers, eight in Fuzhou and one in Hong Kong, had departed on the New York to Hong Kong flight at 10:40 am on May 27.

A total of 260 passengers and 14 crew members were on the New York to Hong Kong flight. After arrival in Hong Kong, 63 passengers transferred to the Hong Kong to Fuzhou flight, 91 passengers disembarked at Hong Kong, and 106 passengers transferred to flights bound for other cities in China or Southeast Asia. The Centre for Health Protection at the Hong Kong Department of Health traced 19 of 91 passengers who disembarked in Hong Kong. One had ILI and a confirmed H1N1 infection. The attack rate for the 63 Fuzhou passengers and 19 Hong Kong passengers who could be evaluated was 11 percent.

All nine infected passengers had mild, self-limiting ILI characterized by fever, and cough, or sore throat. Onset of fever or respiratory illness occurred during May 30–June 1, or three days, the median onset time during the second 12 hours of May 30, suggesting a point source. Using the 2.5-day median incubation periods for H1N1, the most probable exposure period was from midnight to noon on May 28th, which coincides with the final six hours of the New York to Hong Kong flight, waiting in the Hong Kong airport, and during the Hong Kong to Fuzhou flight. The maximum estimated exposure period for this point-source outbreak was from 12 hours before departure from New York to 12 hours after arrival in Fuzhou. Case-passengers sat throughout economy-class cabins on the New York to Hong Kong flight.

All 144 passengers and crew members on the Hong Kong to Fuzhou flight and the 91 passengers and crew members on the New York to Hong Kong flight were screened for fever and respiratory symptoms at arrival at Fuzhou airport. The other 106 passengers who flew to other cities in China or Southeast Asia were not screened in Hong Kong. One passenger, on arrival in Fuzhou, had fever and a stuffy nose, but duplicate nasopharyngeal specimens were negative for H1N1 virus and repeat temperature checks showed no fever. Three days later, ILI abruptly developed in this passenger, and infection with H1N1 virus was confirmed. This passenger and two contacts in New York had nasal congestion without fever or ILI since May 16. No other case-passenger recalled recent respiratory illness before or during the flights or contact with any person with respiratory illness during the week before departure or with another passenger who had respiratory illness during either flight or after arriving in Fuzhou. During the five days before onset, one person had taken another flight and one had visited a tourism site in New York.

Discussion

During this outbreak, H1N1 virus appeared to have been transmitted on a New York to Hong Kong flight. No other common time–place exposure could account for the point-source pattern. The most probable exposure period was during the New York to Hong Kong flight, in the Hong Kong airport, or during the Hong Kong to Fuzhou flight. Our results do not support exposure in New York before arrival at the airport, except that the estimated exposure period included the final 12 hours in New York. Exposure at common points at the airport in New York would have been brief and thus unlikely to lead to a high attack rate.

This outbreak highlights the role of air travel in spread of influenza infections. All nine infected passengers during the incubation period passed through airport fever and symptom screening, indicating that transmission on flights can escape detection. Also, 106 passengers on the New York to Hong Kong flight flew to other destinations and passed through different quarantine posts. In addition, an unknown number of the 91 passengers who traveled to Hong Kong continued into China by bus, ferry, train, and car through different quarantine posts. By the time we recognized the link to the New York to Hong Kong flight, passengers had dispersed and could not be traced.

Airborne transmission in the airplane might be possible. Experiments and simulations show that particles less than two microns in diameter could be distributed widely, albeit at a low concentration, from a single source through an aircraft cabin. Influenza outbreaks in a train and an aircraft cabin with nonoperating air conditioning showed wide distribution of secondary cases, suggestive of airborne transmission. Infection from a fellow passenger should also have resulted in clustering from the much longer and closer exposure to respiratory droplet and aerosols during the 20-hour exposure during the flight.

Observational studies in hospitals, households, and community settings have shown a range of protective effects of face mask use against confirmed influenza, ILI, or respiratory infection. Several factors might explain the stronger effect observed in this outbreak. Exposure was for less than 24 hours in a confined space with limited activity of exposed persons. Compliance with face mask use was probably greater among travelers on a single flight who were concerned about unpredictable health effects of the new virus.

Because long-distance air travel is a major route of dissemination of influenza virus, our findings regarding the effect of face mask use on flights should be evaluated further and considered for decreasing the spread of influenza virus.

Direct experimentation and computer simulations indicate that N95 face masks should reduce the risk for airborne transmission of influenza virus by aerosols containing droplet nuclei in aircraft cabins by 90 percent. Less efficient face masks, such as surgical or medical, also decrease exposure to aerosols of droplet nuclei to a lesser degree than N95 masks, and they provide protection against larger droplets. We did not determine the type of mask worn by the passengers; presumably, individually acquired masks represented a mixture of N95 and other less efficient masks. Our findings are based on a small number of influenza infections, and an actual effectiveness of 90 percent is well within the confidence level of our estimate. The source case-person or persons of influenza virus on the flight might have taken a cough suppressant and

might not have been actively coughing. If influenza virus had been expelled by normal breathing only, protection by an N95 mask for a 4-hour flight could approach 100 percent. Finally, infection from larger inspired or inoculated droplets from an infected person who actively circulated throughout the economy cabin could also explain the observed protection afforded by less-efficient mask types.

In summary, this outbreak probably resulted from a common source exposure to H1N1 virus on the New York to Hong Kong flight. Wearing a face mask was associated with a decreased risk for influenza acquisition during this long-duration flight. We recommend a more comprehensive intervention study to accurately estimate the protective effect of face masks for preventing influenza virus transmission on long-distance flights.

I'm Dr. Mike Miller for *Emerging Infectious Diseases* and I've been reading an abridged version of *Protection by Face Masks against H1N1 Virus on Trans-Pacific Passenger Aircraft, 2009*. You can read the entire article online now and in the September 2013 issue of Emerging Infectious Diseases at cdc.gov/eid.

If you'd like to comment on this podcast, send an email to eideditor@cdc.gov.

[Announcer] For the most accurate health information, visit www.cdc.gov or call 1-800-CDC-INFO.