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AN OUTBREAK OF INFLUENZA ABOARD A COMMERCIAL AIRLINER

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Moser, M. R., T. R. Bender (Alaska Investigations Division, Center for Disease Control, Anchorage, AK 99501), H. S. Margolis, G. R. Noble, A. P. Kendal and D. G. Ritter. An outbreak of influenza aboard a commercial airliner. *Am J Epidemiol* 110:1-6, 1979.

A jet airliner with 54 persons aboard was delayed on the ground for three hours because of engine failure during a takeoff attempt. Most passengers stayed on the airplane during the delay. Within 72 hours, 72 per cent of the passengers became ill with symptoms of cough, fever, fatigue, headache, sore throat and myalgia. One passenger, the apparent index case, was ill on the airplane, and the clinical attack rate among the others varied with the amount of time spent aboard. Virus antigenically similar to A/Texas/1/77 (H3N2) was isolated from 8 of 31 passengers cultured, and 20 of 22 ill persons tested had serologic evidence of infection with this virus. The airplane ventilation system was inoperative during the delay and this may account for the high attack rate.

aircraft; disease outbreaks; Influenza; travel

Travel by commercial airline places large numbers of people in confined spaces for extended periods of time and moves them to varied and distant locations. Although the potential for epidemic disease transmission is present, outbreaks among airline passengers are in-

frequently reported. The few that have occurred have been epidemics of gastroenteritis, and they have been foodborne (1-5). This report presents an unusual outbreak of influenza that occurred in Alaska in March, 1977, among passengers and crew aboard a commercial jet

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aircraft following exposure to an acutely ill passenger.

BACKGROUND

On the morning of March 14, 1977, a Boeing 737 jet having a forward freight compartment and a 56-seat passenger compartment was en route from Anchorage to Kodiak with an intermediate stop in Homer. Five crew members and 24 passengers boarded the aircraft in Anchorage. In Homer, six passengers, all members of a single family, left the airplane and an additional 31 persons boarded. The passengers boarding in Homer, consisting of members of two groups and an additional person traveling alone, brought the total number of passengers to 49. During takeoff, the airplane's left engine failed and takeoff was aborted without injury to passengers, aircraft, or cargo. During the delay, many passengers remained on board and a few waited in the vicinity of the terminal building.

Four and one-half hours after the engine failed, an alternate turboprop aircraft capable of carrying only 34 passengers was flown in to continue the flight to Kodiak. This aircraft took most of the passengers from Homer to Kodiak and then returned to Homer and took 15 remaining passengers and five crew members back to Anchorage. That evening these 15 passengers boarded a second jetliner and were flown directly to Kodiak.

The following day, seven passengers were seen by a physician in Kodiak because they were ill with a severe respiratory syndrome characterized by the sudden onset of fever, headache, shaking chills, myalgia, and a severe nonproductive cough. Two were hospitalized. In Anchorage, two crew members were hospitalized with similar symptoms 60 hours after the flight. Public health authorities were informed of the outbreak, and an investigation was begun.

METHODS

Passengers and crew members were interviewed in person or by telephone using a specially prepared questionnaire. Each was asked about symptoms and time of onset, relationship to the other passengers, exposure to others with a similar illness, itinerary, seat location on the aircraft, activities during the delay, food history, past medical history, smoking history, and whether medical attention was sought for illness. A second questionnaire requesting detailed information on seating, history of influenza immunization, duration of symptoms, and whether a similar illness had occurred among household contacts was mailed to all passengers and crew nine days after the initial interview. Only one person on the airplane was not contacted during the investigation, and this individual was excluded from further analysis.

A person was considered a case if the individual had a temperature ≥ 37.7 C or complained of fever, and had any two of the following symptoms: cough, chills, myalgia or arthralgia, difficulty walking, chest pain, severe malaise, or headache. In addition, a person was considered a case if no fever was present and that individual had any three of the above symptoms. To determine whether exposure was likely to have been nearly simultaneous in all patients, the history of onset of illness was used to apply the curve-fitting techniques suggested by Sartwell (6) for evaluation of the distribution of incubation periods.

Throat swabs for virus isolation were obtained within 96 hours from most passengers and specimens were transported frozen in tryptose-phosphate broth with 0.5 per cent gelatin. The swabs were then inoculated into embryonated chicken eggs and primary rhesus monkey kidney cells for virus isolation. Serum samples were frozen and shipped to the laboratory, where antibody titers to in-

fluenza were determined by hemagglutination-inhibition tests (7). A 4-fold titer rise between paired sera to A/Alaska/77 (an organism found to be related to A/Texas/1/77) was considered serologic evidence of infection.

The background level of disease in Kodiak was estimated by telephone survey. The population surveyed included all available families in Kodiak with one or

more children in grades 9-13 who were absent from school for any period within five days after the flight. In addition, physicians and public health personnel in the communities that the passengers visited prior to the flight were polled by telephone regarding cases of influenza-like illness.

RESULTS

Of the 53 passengers and crew who were on the airplane when the engine malfunctioned, 38 (72 per cent) subsequently became ill (the one person not contacted is excluded from analysis), while none of the six passengers who deplaned in Homer were affected. All cases occurred within a very short time (see figure 1), the estimated median time of onset of illness being 38 hours after the delay.

Symptoms were characteristically sudden in onset, with fever to 40 C, severe nonproductive cough, and extreme fatigue (table 1). Four persons required hospitalization. Among 26 of the cases available for follow-up, the duration of illness averaged six days (range 2-12 days) when illness was defined as cough and fatigue. Symptoms of fever, chills, and myalgia were present for an average of two days (range 0.5-5 days).

Epidemiologic investigation revealed

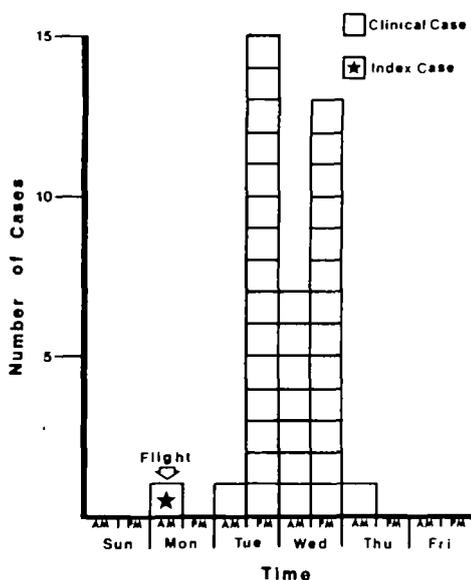


FIGURE 1. Onset of clinical influenza among 37 persons following exposure to an index case aboard a delayed airliner, Homer, Alaska, March, 1977.

TABLE 1

Distribution of symptoms among persons following exposure to influenza on board a delayed airliner, Homer, Alaska, March, 1977

Symptom	% of clinical cases (N = 38)	% of noncases (N = 15)
Cough	95	20
Fever	92	0
Fatigue	92	20
Headache	87	13
Sore throat	71	20
Myalgia/arthralgia	61	7
Chills	58	0
Photophobia/burning eyes	53	0
Chest pain	39	7
Abdominal cramps/diarrhea	39	33
Difficulty walking	37	0

that a 21-year-old woman who joined the flight in Homer became acutely ill with fever, chills, and cough 15 minutes after boarding. She continued to have a severe cough while remaining on the airplane throughout the delay and also during her subsequent trip directly to Kodiak from Homer. Prior to the flight, she had stayed with a family of three in their small cabin located between Homer and Anchorage. Thirty-six hours before the flight, she and the two adult members of this host family plus three other persons visited several lounges and restaurants in a nearby community. Within an hour after taking her to the airport, both adult hosts became ill with influenza-like symptoms. Their 4-year-old child became ill 36 hours later. No influenza-like symptoms were reported among three remaining preflight contacts of this passenger.

Passengers stayed on the airplane for varying periods following the aborted takeoff. Thirty persons (including the index case) remained on board throughout the delay, while the other 23 left and returned for varying periods of time. On the airplane, people moved freely throughout the passenger compartment, and crew members took those persons who were interested through the cargo area to the cockpit. One person left the airplane and chartered another plane to Anchorage.

Those passengers who were on the disabled airplane for more than three hours had the highest attack rate (table 2). Moreover, this attack rate varied by groups of persons on board; e.g., crew, 40

per cent; Anchorage boarding passengers, 58 per cent; and Homer boarding passengers, 83 per cent. Among these groups, those with higher attack rates were again the persons who had been on the airplane longer. However, no significant association was demonstrated between illness and the sex of a person, previous history of lung disease, smoking status, history of recent bivalent swine influenza vaccination, activity while waiting on the airplane, or routing to Kodiak following the delay.

Of the 38 cases, 31 had specimens for viral culture collected 2–3 days after the onset of symptoms, and eight of these were positive for influenza A virus designated A/Alaska/1–8/77. When tested with reference sera in hemagglutination-inhibition reactions, all isolates were found to resemble A/Texas/1/77 (8). Several isolates were also confirmed by neuraminidase-inhibition tests and shown to have N2 neuraminidase similar to that of A/Texas/1/77. Twenty of the 22 cases with paired sera available for testing had a greater than 4-fold rise in antibody titer to A/Alaska/1/77.

The index case had an 8-fold rise in titer of antibodies to A/Alaska/77, although her throat culture was negative. Viral cultures were obtained from eight of the 17 persons on the plane who did not meet the case definition, and all were negative. Paired sera were collected from six of the noncases, and two had 4-fold or greater rise in antibody to A/Alaska/77. Within a week after these passengers arrived in Kodiak, seven additional clinical cases occurred among 35 household contacts, for a secondary attack rate of 20 per cent. Viral cultures (but not sera) were obtained from two of these seven cases, and A/Alaska/77 virus was isolated from one. Of the five remaining cases, three were studied serologically and all (including the two roommates of the index case) had antibody rises to influenza.

TABLE 2

*Association of clinical influenza with time spent on delayed airliner, Homer, Alaska, March, 1977**

Time (hours)	No.† (ill/at risk)	Attack rate (%)
<1	8/15	53
1–3	5/9	56
>3	25/29	86

* $\chi^2 = 6.657$ ($p < 0.05$).

† Excludes index case.

During the week of the outbreak, no influenza-like illness was found among the school population of Kodiak. No cases of influenza-like illness in Kodiak or the communities frequented by the index case were reported for the two weeks prior to the flight nor for the subsequent 10 days. In the week prior to this outbreak, two isolates of A/Texas/1/77-like virus were obtained in Anchorage and Fairbanks.

DISCUSSION

Influenza most commonly spreads from person to person, and common-source, single exposure epidemics are rarely reported. The common-source nature of this epidemic is suggested by the history of the outbreak. That is, passengers involved had been placed together with an ill person in an enclosed, poorly ventilated space, and the attack rate was high among unrelated groups of people who were exposed on the airplane but who came from areas of no known influenza activity. Furthermore, when cumulative illness onset times are plotted according to the method of Sartwell (6), a log normal distribution of incubation periods results which also suggests a common-source, single exposure epidemic.

Although influenza virus was not recovered from the index case, she had a greater than 4-fold rise in antibody titer to A/Alaska/77. Prior to boarding the airplane, she had no known contact with influenza, but she and her preflight contacts became ill with influenza-like illness almost simultaneously. All of the persons on the flight who became ill were exposed to her, and, following her arrival in Kodiak, both of her roommates became ill.

In this outbreak, people were exposed to an index case in very crowded circumstances. During normal operation, the airplane ventilation system was designed to completely exchange the air in the passenger compartment, a volume of 3 m^3 , every four and one-half minutes.

The airflow from ceiling to floor was laminar, with little fore-to-aft turbulence between rows. However, following engine failure, the ventilation system was turned off and the doors were kept closed for approximately two hours. Later, when the front cargo and rear passenger compartment doors were opened, most passengers felt that the compartment was comfortable or warm although the outside temperature was 1.7 C (29 F), suggesting that there was poor air exchange even during this period.

Spread of influenza virus is via droplets or droplet nuclei (9), and the period of infectivity of these particles is prolonged by low humidity (10). The high clinical attack rate among passengers aboard the aircraft was probably the result of their exposure to large aerosols of droplets produced by an ill passenger in a confined, stagnant and dry airspace. Proper operation of the air circulation equipment and isolation of the ill passenger might have prevented spread of the influenza virus. This epidemic demonstrates that transportation personnel who deal with passengers must be aware of the circumstances in which respiratory illness can spread on board public conveyances, and it suggests ways to avoid potential outbreaks of influenza and other respiratory diseases during travel delays.

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