

Large Summertime Influenza A Outbreak among Tourists in Alaska and the Yukon Territory

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We investigated a large summertime outbreak of acute respiratory illness during May–September 1998 in Alaska and the Yukon Territory, Canada. Surveillance for acute respiratory illness (ARI), influenza-like illness (ILI), and pneumonia conducted at 31 hospital, clinic, and cruise ship infirmary sites identified 5361 cases of ARI (including 2864 cases of ILI [53%] and 171 cases of pneumonia [3.2%]) occurring primarily in tourists and tourism workers (from 18 and 37 countries, respectively). Influenza A viruses were isolated from 41 of 210 patients with ILI at 8 of 14 land sites and 8 of 17 cruise ship infirmaries. Twenty-two influenza isolates were antigenically characterized, and all were influenza A/Sydney/05/97–like (H3N2) viruses. No other predominant pathogens were identified. We estimated that >33,000 cases of ARI might have occurred during this protracted outbreak, which was attributed primarily to influenza A/Sydney/05/97–like (H3N2) viruses. Modern travel patterns may facilitate similar outbreaks, indicating the need for increased awareness about influenza by health care providers and travelers and the desirability of year-round influenza surveillance in some regions.

In the United States, winter influenza epidemics result in an annual average of ~114,000 excess hospitalizations and >20,000 deaths [1]. Elderly persons are disproportionately affected by complications of influenza, including pneumonia, exacerbation of chronic cardiac or pulmonary diseases, and death [2]. Summertime influenza outbreaks of limited size have occurred sporadically in the United States and Canada [3], but large,

sustained summertime outbreaks in temperate countries have not been reported.

During May–September 1998, an estimated 1.16 million persons (~53,000 tourists per week) visited Alaska and the Yukon Territory [4]. The combined 1998 resident population of this region was ~650,000 persons [5, 6]. Most tourists visited central and southern coastal Alaska and southwestern Yukon. About 40% entered Alaska by cruise ship [4]. Some cruise ship passengers, either before or after cruises, also traveled overland by bus or train in groups of 40–50 persons. Alaska cruise ships typically carried 1000–1500 passengers and 500–800 crew members on cruises of 3–14 days. Most crew members worked aboard ships for the duration of the tourism season.

In June 1998, respiratory illnesses among a group of 37 military retirees were reported to the Centers for Disease Control and Prevention (CDC). The group had traveled on a combined overland and sea tour of Alaska and the Yukon Territory, and >50% of the people in

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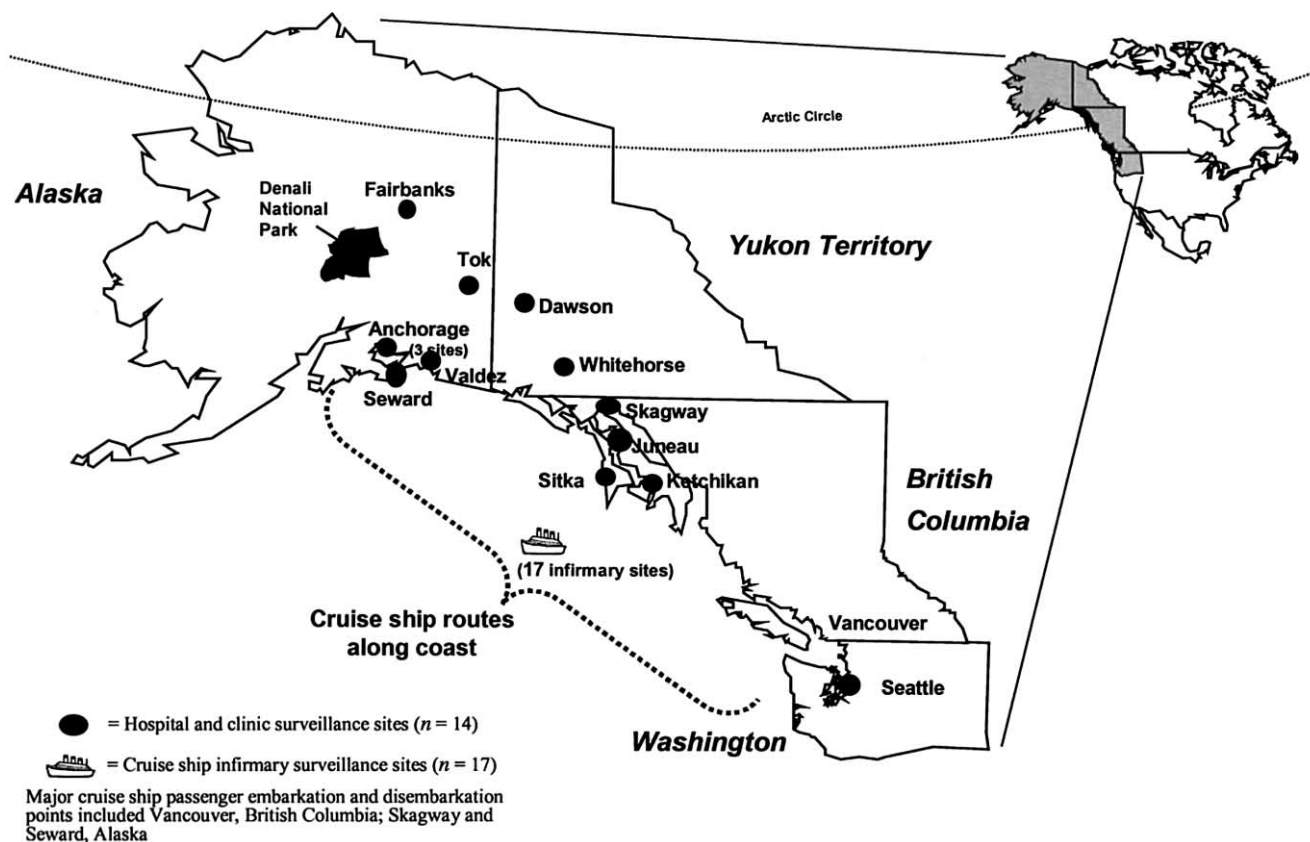


Figure 1. Investigation area and prospective surveillance sites ($n = 31$) for acute respiratory illness, influenza-like illness, and pneumonia—Alaska, Washington, British Columbia, and Yukon Territory, 1998.

the group developed respiratory illness during their trip, including 5 (14%) who developed pneumonia. After similar respiratory illness clusters were reported, a multiagency epidemiological investigation was initiated in July. The objectives of the investigation were to determine the magnitude and etiology of the outbreak and to develop control recommendations. We report the findings of an investigation of a large, summertime outbreak of acute respiratory and influenza-like illnesses in 1998 that occurred primarily among travelers to this region.

METHODS

We conducted retrospective and prospective surveillance and collected reports from health care providers, tourists, and tourism workers to identify cases of respiratory illness.

Case definitions. A case of acute respiratory illness (ARI) was defined as cough or sore throat with onset during the period 1 May to 30 September 1998. Illnesses occurring in tourists >10 days after completion of travel in Alaska and Canada were excluded. A case of influenza-like illness (ILI) was considered a subcategory of ARI and was defined as ARI with fever of $\geq 37.8^{\circ}\text{C}$ (100.0°F) or self-reported feverishness. A case of pneumonia was defined as ARI with radiographic evidence

of pneumonia. A tourist was defined as a person visiting Alaska or the Yukon Territory for leisure. A tourism worker was defined as a person employed by the tourism industry (including aboard cruise ships) during the period 1 May to 30 September 1998. A resident was defined as a person whose primary residence was Alaska or the Yukon Territory who was not a tourism worker.

Prospective surveillance. During the period 6 August to 30 September 1998, prospective surveillance was conducted at 14 land-based hospitals and clinics and at 17 cruise ship infirmaries. Land-based sites were located either where travelers had access to medical care or where large numbers of tourists potentially had contact with residents and tourism workers (figure 1). These included 11 hospitals or clinics in Alaska, 2 in the Yukon Territory, and 1 in Seattle, Washington, where some tourists sought medical care after completing travel. Each of the participating 17 cruise ships sailed in southeastern Alaska waters and carried >120 passengers on multiple-day journeys. Nine ships reported cases of respiratory illness before 1 August 1998, and all participated in prospective surveillance. Eight ships were randomly selected from 19 remaining ships sailing in the region. Standardized questionnaires were used to collect information on patient age, sex, residence, status (i.e., tourist,

resident, or tourism worker), respiratory illness symptoms, illness onset date, and a health care practitioner's illness assessment.

Retrospective surveillance. Medical records from 5 of 17 cruise ships that sailed on 7-day cruises were reviewed to identify cases of ARI that occurred among tourists during the period 1 May to 5 August 1998. A standardized form was used to collect data on patient age, sex, residence, respiratory illness symptoms, and illness onset date. We also reviewed medical records and collected the same data for the same period during 1997 from 2 of the same ships that sailed 7-day cruises in this area.

Publicly solicited reports. During the investigation, we solicited reports of ARI that occurred during 1 May to 30 September 1998 through public health bulletins and media advisories. A standard case report form was used to collect information on patient age, sex, residence, respiratory illness symptoms, visits to health care providers, clinical outcome, and travel history, and persons were contacted to supplement missing information. Cases of pneumonia were confirmed by reviewing medical records and radiology and laboratory results.

Calculation of respiratory illness rates among cruise ship populations. For the periods May–August in both 1997 and 1998, retrospective surveillance data were used to calculate respiratory illness rates among cruise ship tourists. For the period 6 August to 30 September 1998, prospective surveillance data were used to calculate respiratory illness rates among cruise ship tourists and tourism workers. Denominator data to estimate rates were obtained from participating cruise ships. Cruise ship workers were assumed to have worked for the entire season. Respiratory illness rates were not calculated for tourists or tourism workers who did not board cruise ships, because reliable denominator information was not available.

Laboratory testing. Nasopharyngeal (NP) swab specimens were collected weekly from the first 5 case patients with ILI (at land-based sites) or the first 5 case patients with ARI (at ship infirmaries) of ≤ 4 days' duration during prospective surveillance. Specimens were tested for viral and bacterial pathogens. NP swab specimens were requested from all case patients with pneumonia and tested for bacterial pathogens at the CDC Arctic Investigations Program Laboratory (Anchorage, AK). NP swabs specimens collected at Alaska sites or aboard cruise ships in Alaska waters were tested by standard respiratory virus isolation techniques at the Alaska State Public Health Virology Laboratory (Fairbanks, AK) [7, 8]. A subset of Alaska influenza A virus isolates was subtyped and antigenically characterized at CDC (Atlanta, GA) [9]. NP swabs collected at the Seattle clinic site were tested by viral culture at the Washington State Department of Public Health Laboratory (Seattle, WA) [7, 8], whereas NP swabs collected in the Yukon Territory, British Columbia, and on cruise ships in Canadian waters were tested

by viral culture at the British Columbia Centre for Disease Control Society Provincial Laboratory (Vancouver, BC, Canada) [10, 11]. Blood and sputum culture results for patients with pneumonia who were hospitalized at surveillance sites were obtained.

RESULTS

Case-finding. The outbreak persisted for >5 months and declined when the tourist season ended (figure 2). During the period 1 May to 30 September 1998, surveillance identified 5361 cases of ARI, including 2864 (53%) cases of ILI and 171 (3.2%) cases of pneumonia. Four pneumonia-related deaths were reported, all of elderly persons. Cases of ARI occurred in tourists from 18 countries, including residents of every US state and of 5 Canadian provinces and territories, and in tourism workers from 37 countries.

During prospective surveillance, we identified 2799 cases of ARI: 75% involved tourists, 22% involved tourism workers, and 3% involved local residents (table 1). Case patients ranged in age from 6 months to 94 years (median, 62 years). Tourists who became ill with ARI (median age, 66 years) were substantially older than tourism workers (median age, 29 years) or residents (median age, 38 years) who became ill with ARI. Women accounted for 48% of case patients. Pneumonia occurred in 2.4% of cases of ARI, with affected persons aged 21–91 years (median, 72 years).

Illness rates among cruise ship populations. During the period May–August 1998, there were 11.6 visits for ARI to ships' infirmaries per 1000 tourists. This was more than twice the rate of 5.3 visits for ARI per 1000 tourists during the same period in 1997 (rate ratio, 2.2; 95% CI, 1.6–3.0). During the period 6 August to 30 September 1998, there were 15.8 and 9.2 infirmary visits for ARI per 1000 persons per week among cruise ship passengers and tourism workers, respectively.

Laboratory testing. Of 216 NP swab specimens collected, 210 were cultured and 58 viral isolates identified. Of these, 41 (71%) were influenza A viruses, whereas the remaining isolates included rhinoviruses, parainfluenza viruses, and 1 adenovirus (table 2). Twenty-two influenza A isolates were antigenically characterized, and all were A/Sydney/05/97-like (H3N2) viruses. Influenza viruses were isolated from tourists, tourism workers, and residents from 16 surveillance sites (8 hospitals or clinics and 8 ships). Six (40%) of 15 NP swabs specimens collected from patients with pneumonia yielded influenza viruses. Routine culture of blood and sputum samples did not reveal a common bacterial etiology for the cases of pneumonia.

DISCUSSION

This investigation documented the largest nonpandemic summertime influenza outbreak in North America. We identified

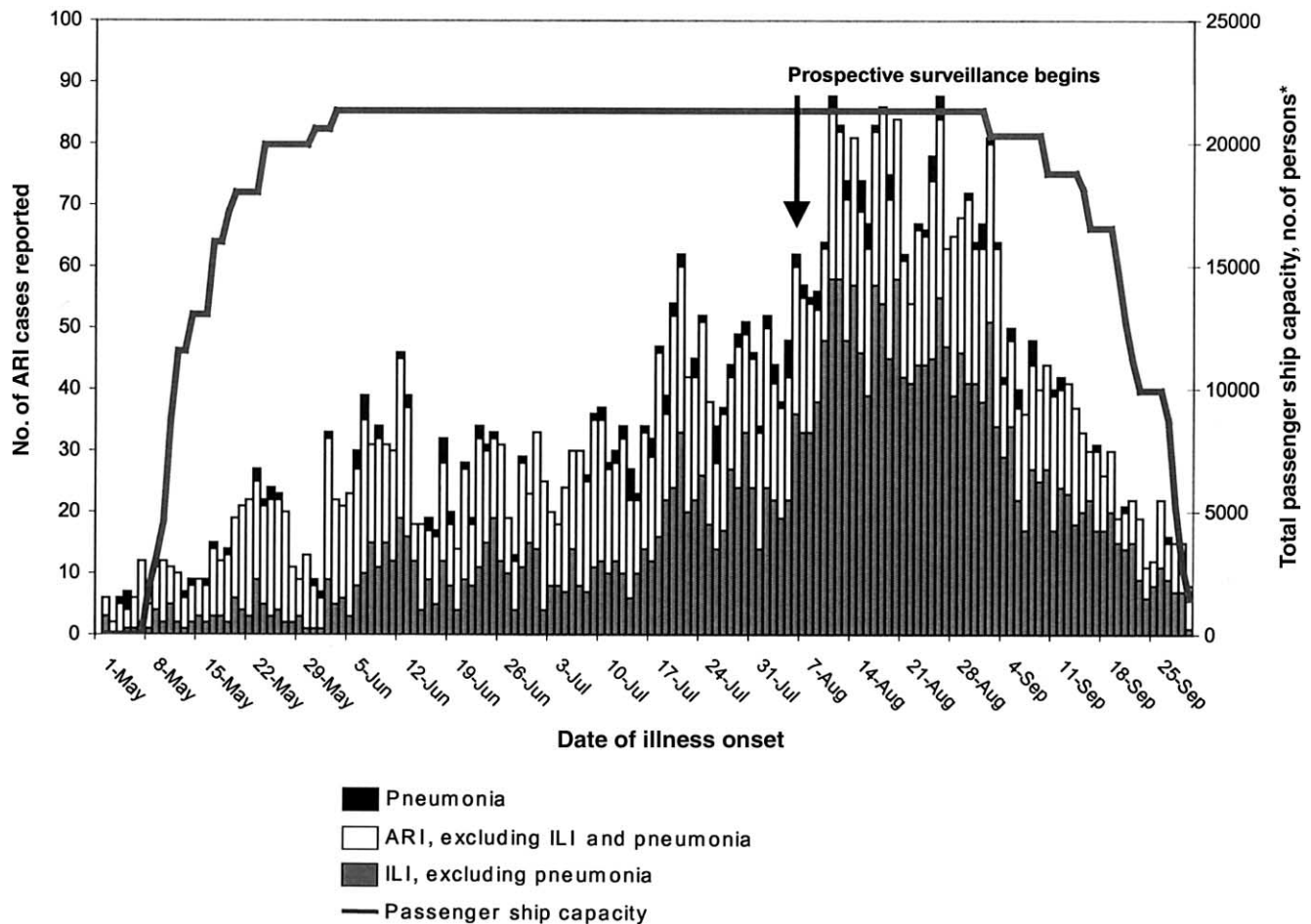


Figure 2. Cases of acute respiratory illness (ARI; $n = 5361$) identified through prospective and retrospective surveillance and publicly solicited reports by date of illness onset, Alaska and Yukon Territory, 1 May to 30 September 1998. *Passenger ship capacity is not limited to ships participating in surveillance but includes all cruise ships sailing in Alaska waters. The number of tourists in the region is proportional to passenger ship capacity. The increase (May) and decrease (September) in passenger-carrying capacity reflects the arrival and departure of ships in the region. ILI, influenza-like illness.

>5300 cases of ARI, and review of cruise ship data found that the rate of ARI was significantly higher among passengers during 1998 than during 1997. Influenza A viruses were isolated from ill tourists, tourism workers, and Alaska and Yukon Territory residents. The primary pathogen for this outbreak was identified as influenza A/Sydney/05/97-like (H3N2) virus. No other predominant viral or bacterial respiratory pathogens were identified in sufficient numbers to explain this outbreak.

Numerous factors might have facilitated transmission of influenza among travelers in the same overland tour group in buses and trains or same cruise ship. Influenza viruses are usually transmitted from person to person via respiratory droplets expelled through coughing and sneezing, and attack rates among susceptible groups can be high. For example, an influenza A outbreak aboard a US Navy ship resulted in an attack rate of 42% for influenza-like illness among crew members [12]. Shared itineraries probably facilitated influenza transmission

among different tour groups. Nearly all organized overland tours followed the same route in Alaska and the Yukon Territory, and tourists from different groups shared a limited number of hotels, restaurants, riverboat trips, buses, and trains. Overland travelers congregated at common destinations at ports and at tourist destinations on the highway system of Alaska and the Yukon Territory.

Our surveillance systems likely underestimated the outbreak magnitude. Although prospective surveillance identified more cases of ARI than did publicly solicited reports and retrospective surveillance, prospective surveillance identified cases of ILI only at selected sites and did not identify cases seen at nonsurveillance facilities. Also, prospective surveillance did not include 11 large cruise ships and several smaller ships that sailed in the region during the outbreak. If these ships, which carried ~30% of total cruise ship passengers, had rates of ARI throughout the season similar to those of the surveillance ships, then ~2054

Table 1. Demographic, clinical, and laboratory characteristics of cases of acute respiratory illness (ARI) and case patients as identified through prospective surveillance, Alaska and Yukon Territory, 6 August to 30 September 1998.

Characteristic	Tourists	Tourism workers	Residents ^a	Patients of unknown status	Total
Case definition					
ARI (excluding ILI and pneumonia)	654 (66)	327 (33)	—	3 (<1)	987 (100)
ILI (excluding pneumonia)	1376 (79)	285 (16)	66 (4)	18 (1)	1745 (100)
Pneumonia	59 (88)	4 (6)	3 (4)	1 (2)	67 (100)
Total	2089 (75)	616 (22)	69 (3)	22 (<1)	2796 (100)
Patient age, years					
Median	66	29	38	64	—
Range	0.5–94	19–88	7–85	0.5–77	—
IQR, 25%–75%	57–73	25–37	25–50	32–69	—
Viral culture specimens					
Influenza A isolates ^b	127 (61)	32 (15)	47 (22)	4 (2)	210 (100)
Influenza A isolates ^b	35 (85)	1 (2)	4 (10)	1 (2)	41 (100)
Influenza A (H3N2) only ^c	11 (85)	0	1 (8)	1 (8)	13 (100)
Influenza A/Sydney/05/97—like (H3N2) virus	20 (91)	0	2 (9)	0	22 (100)

NOTE. Data are no. (%) of patients, unless indicated otherwise. Percentages are rounded and so do not always add up to 100%. ILI, influenza-like illness; IQR, interquartile range.

^a Residents were evaluated at hospital and clinic sites that conducted surveillance only for ILI and pneumonia.

^b Six isolates were not characterized.

^c Isolates not characterized.

additional cases of ARI might have been missed. Many persons with ARI probably did not seek care at surveillance sites. For example, during a 1997 cruise ship influenza outbreak, only 22% of persons with ARI sought care at the ship's infirmary [13]. If that pattern was true for this outbreak, then 28,343 additional cases of ARI might have occurred among cruise ship passengers. Our surveillance also did not track any cases of ARI, ILI, or pneumonia among travelers who presented to health care providers after departing the region. On the basis of these considerations and the frequency of culture-confirmed influenza A virus infections, as many as 33,704 cases of ARI and 12,683 cases of influenza A might have occurred during this outbreak. Because some persons with respiratory illness were treated with antibiotics on ships before transfer to hospitals, we may have also underestimated cases of bacterial pneumonia.

Several epidemiological features of this outbreak are notable. Isolated outbreaks on summer cruise ships have been reported in both the Southern and Northern Hemispheres [14–16]. However, reported summertime influenza outbreaks in the United States, including 1 outbreak among a small group of overland and cruise ship tourists in Alaska [17], have been substantially smaller and shorter, generally ending within 6–8 weeks [3, 18, 19]. In contrast, this summertime influenza outbreak was large and persisted for >5 months. We hypothesize that the outbreak was sustained by the continuous weekly arrival of large numbers of susceptible overland and cruise ship passengers. This is plausible because the incidence of ARI even-

tually decreased, but only after tourists and tourism workers left the region in September and October.

Another notable finding was the low number of cases of ARI in residents compared with tourists (3% in residents; 75% in tourists). This might reflect limited exposure to infected tourists, a lower likelihood of developing complications from influenza, or an ascertainment bias in our hospital and clinic-based surveillance system. For example, Alaska residents are substantially younger than tourists and may have been less likely to seek medical attention for ARI symptoms.

The circumstances precipitating the outbreak are unclear. It is possible that influenza viruses were circulating among residents of the region before the arrival of susceptible tourists and that these viruses initiated the outbreak. Influenza viruses were isolated sporadically in Alaska during May in 5 of 8 years from 1990 to 1997 (unpublished data, Alaska State Public Health Virology Laboratory). During the 1997–1998 influenza season, influenza A/Sydney/05/97—like (H3N2) viruses were isolated from Alaska residents (unpublished data, CDC) and were the predominant influenza strain in the United States and Canada [20, 21]. It is also possible that acutely ill tourists or tourism workers could have introduced influenza, because ill tourists originated from 18 countries, and ill tourism workers came from 37 countries, including countries in the Southern Hemisphere and the tropics where influenza A/Sydney/05/97—like (H3N2) viruses were circulating during the outbreak [20, 21]. During the period April to September 1998, ninety-eight percent of the 312 influenza A (H3N2) virus isolates antigenically

Table 2. Viruses isolated from cases of acute respiratory illness, as identified through prospective surveillance, Alaska and Yukon Territory, 6 August to 30 September 1998.

Viruses, strain	No. of isolates (% of isolates of specific virus)	Percentage of total isolates
Influenza A	41	71
A, not subtyped	6 (14.6)	
A (H3N2) subtype only ^a	13 (31.7)	
A/Sydney/05/97-like (H3N2) ^b	22 (53.7)	
Rhinovirus	11	19
Parainfluenza virus	5	9
Serotype 1	1 (20)	
Serotype 2	4 (80)	
Not serotyped	0	
Adenovirus	1	1.7
Type 5	1 (100)	
Not subtyped	0	
Total	58	100

NOTE. Of 216 specimens submitted, 210 were suitable for viral culture. An additional 16 influenza A viruses were isolated from respiratory specimens submitted from patients evaluated at nonsurveillance sites in Alaska and Yukon Territory with illness onset during the period from 5 June to 20 September 1998. These isolates were antigenically characterized at the Centers for Disease Control and Prevention, and 100% were A/Sydney/05/97-like (H3N2) viruses.

^a These 13 isolates were not antigenically characterized; 100% of isolates subtyped were influenza A (H3N2).

^b No other influenza A (H3N2) strains were identified.

characterized at the CDC (Atlanta, GA) were A/Sydney/05/97-like viruses [21]. These viruses were isolated in North America, Europe, Asia, Central and South America, South Africa, Australia, and New Zealand [21].

We did not track cases of ARI among travelers after they departed the Alaska–Yukon Territory region and do not know whether the return of ill travelers to their home countries precipitated local influenza outbreaks. Influenza A/Sydney/05/97-like (H3N2) virus was the predominant influenza strain worldwide throughout the summer, fall, and winter of 1998–1999 [20–27], and the impact of this outbreak on the global epidemiology of influenza is unknown. Regardless, this outbreak demonstrates that modern travel patterns, including large international tourist groups, can be associated with the development of large “nonseasonal” outbreaks that might have implications for the global epidemiology of influenza.

The unusual timing and size of this outbreak posed several public health challenges. Identification of the outbreak was delayed by the absence of summertime influenza surveillance, and many of the health care providers who evaluated cases of ARI initially did not consider influenza as a diagnosis. Close coordination with the travel industry, US state and federal public health agencies, and Canadian provincial and national public

health agencies was essential for rapid implementation of the surveillance system.

In response to the outbreak, influenza prevention and control recommendations were made to the travel industry and health care providers [28]. However, the recommendations were limited by the difficulty of obtaining influenza vaccine. The 1997–1998 influenza vaccine expired on 30 June 1998, and the 1998–1999 vaccine was generally not available until September 1998. Persons who had been vaccinated with the 1997–1998 influenza vaccine remained susceptible to infection with the outbreak strain, influenza A/Sydney/05/97-like (H3N2) virus, because this vaccine did not confer protective immunity against the antigenically drifted outbreak strain [20, 21]. However, the 1998–1999 influenza vaccine did include this strain and could have prevented many infections if it had been widely available [20]. The lack of influenza vaccine during the summer months constitutes a “vulnerable window” for responding to summertime influenza outbreaks.

In the absence of influenza vaccine, the only option for providing specific protection against influenza is antiviral chemoprophylaxis. Although chemoprophylaxis can be effective in preventing influenza, antiviral drugs differ in adverse effects, activity against influenza A and B, emergence of antiviral resistance, and cost. Currently, amantadine, rimantadine, and oseltamivir are approved for chemoprophylaxis of influenza A in the United States, but only oseltamivir is approved to prevent influenza B. Mass chemoprophylaxis poses substantial logistical challenges. Daily chemoprophylaxis would be needed during overland and ship travel for travelers, and for longer periods for tourism workers, depending on exposure to influenza. This is impractical because the supply of antiviral drugs is limited, especially during the summer months in North America, and such drugs alone cannot be expected to control large, prolonged influenza outbreaks. During the 1998 outbreak, amantadine and rimantadine were the only approved antiviral drugs for chemoprophylaxis and treatment of influenza A. These drugs were in very limited supply aboard cruise ships and at pharmacies in the affected regions, and rimantadine was not licensed in Canada.

During the summer of 1999, increased ARI rates and transmission of influenza A (H3N2) viruses among tourists again were documented in Alaska and the Yukon Territory [29, 30]. In response, British Columbia and the Yukon Territory implemented year-round influenza surveillance. CDC developed and distributed preliminary guidelines for conducting ARI and ILI surveillance aboard cruise ships and recommendations for responding to respiratory disease outbreaks aboard cruise ships [31]. Outbreaks of influenza among tourists were not reported during the summers of 2000–2002.

Control of any large influenza outbreaks, including those occurring among organized tour groups, depends on early de-

tection of influenza (e.g., by use of rapid influenza diagnostic tests and viral culture), availability of influenza vaccine and antivirals, rapid implementation of control measures, and increased awareness of influenza by health care providers, public health professionals, and the public, including travelers and the travel industry. Implementation of year-round influenza surveillance, especially in selected regions, will help to better define the epidemiology of influenza during the summer in North America and to develop more effective prevention and control measures. The lessons of this outbreak apply to other regions and situations involving organized tour groups, especially if influenza viruses are circulating among persons at travel destinations or if such groups include persons from countries where seasonal influenza activity is occurring.

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