

## An outbreak of cholera from food served on an international aircraft

J. EBERHART-PHILLIPS<sup>1</sup>, R. E. BESSER<sup>1\*</sup>, M. P. TORMEY<sup>2†</sup>, D. FEIKIN<sup>3</sup>,  
M. R. ARANETA<sup>2</sup>, J. WELLS<sup>3</sup>, L. KILMAN<sup>4</sup>, G. W. RUTHERFORD<sup>5</sup>, P. M. GRIFFIN<sup>3</sup>,  
R. BARON<sup>1</sup> AND L. MASCOLA<sup>2</sup>

<sup>1</sup> Epidemic Intelligence Service, Division of Field Services, Centers for Disease Control and Prevention

<sup>2</sup> Acute Communicable Disease Control Unit, County of Los Angeles Department of Health Services,  
313 N. Figueroa Street, Room 231, Los Angeles, CA 90012

<sup>3</sup> Foodborne and Diarrheal Diseases Branch, Centers for Disease Control and Prevention

<sup>4</sup> Public Health Laboratories, County of Los Angeles Department of Health Services

<sup>5</sup> Prevention Services, State of California Department of Health Services

(Accepted 25 September 1995)

### SUMMARY

In February 1992, an outbreak of cholera occurred among persons who had flown on a commercial airline flight from South America to Los Angeles. This study was conducted to determine the magnitude and the cause of the outbreak. Passengers were interviewed and laboratory specimens were collected to determine the magnitude of the outbreak. A case-control study was performed to determine the vehicle of infection. Seventy-five of the 336 passengers in the United States had cholera; 10 were hospitalized and one died. Cold seafood salad, served between Lima, Peru and Los Angeles, California, was the vehicle of infection (odds ratio, 11.6; 95% confidence interval, 3.3–44.5). This was the largest airline-associated outbreak of cholera ever reported and demonstrates the potential for airline-associated spread of cholera from epidemic areas to other parts of the world. Physicians should obtain a travel history and consider cholera in patients with diarrhoea who have travelled from cholera-affected countries. This outbreak also highlights the risks associated with eating cold foods prepared in cholera-affected countries.

### INTRODUCTION

During January 1991, epidemic cholera appeared in South America for the first time in the 20th century [1]. By the end of 1991, the epidemic had spread to 14 countries in Latin America, with nearly 400 000 cases and more than 4000 deaths reported [2]. During the first year of the epidemic, fewer than 20 cases of

cholera associated with travel in Latin America were reported in the United States [3].

On 19 February 1992, the Los Angeles County Department of Health Services and the California Department of Health Services received reports that *Vibrio cholerae* O1 had been isolated from the stools of five hospitalized persons with diarrhoea. One patient, a 70-year-old man, had died. All five had been passengers on the same commercial airline flight on 14 February. The flight originated in Buenos Aires, Argentina, stopped in Lima, Peru and ended in Los Angeles County, California, with the arrival of 336

\* Address for correspondence: Richard E. Besser, M.D., Department of Pediatrics, University of California, San Diego, 200 W. Arbor Drive (8454), San Diego, CA 92116.

† Author for reprints.

passengers. We conducted a study to determine the magnitude of the outbreak and the vehicle of infection.

## METHODS

Confirmed cases of cholera were defined as having both diarrhoea and laboratory evidence of infection with toxigenic *Vibrio cholerae* O1, in accordance with criteria of the Centers for Disease Control and Prevention (CDC) [4]. Diarrhoea was defined as any loose stool during the week after the flight. Laboratory evidence of infection was either a stool culture that grew toxigenic *V. cholerae* O1 or a vibriocidal antibody titre > 640.

Passengers were located using the addresses they had written on declaration cards submitted to the United States Customs Service upon arrival in Los Angeles County. News media appeals also asked passengers to contact local health authorities.

Passengers were interviewed regarding all foods and beverages they had consumed during the flight, as well as their exposures to known risk factors for cholera during the 3 days before the flight. They were asked to describe any gastrointestinal symptoms and any medical care received after the flight. Passengers also were asked to submit stool specimens for culture and serum for vibriocidal antibody titres. Some passengers who could not be reached for interview by the investigating team in Los Angeles County were contacted by health authorities in other states or countries for interviews and specimen collection.

Rectal swabs were plated on thiosulphate-citrate-bile-salts-sucrose agar (TCBS). Colonies typical of *V. cholerae* were subcultured and tested for agglutination with *V. cholerae* O1 polyvalent and monovalent antisera. All *V. cholerae* O1 isolates were biotyped and tested for cholera toxin production by enzyme-linked immunosorbent assay [5]. Serum was tested for vibriocidal antibodies by the microtiter technique [6].

A case-control study was conducted to determine the vehicle of infection. Only passengers who had been interviewed in a standardized manner by investigators in Los Angeles were enrolled. For the case-control study, case-passengers were defined as those whose stool cultures grew toxigenic *V. cholerae* O1, regardless of symptoms. Controls were those passengers who had no gastrointestinal symptoms in the 5 days following the flight, whose stool cultures, if obtained, did not grow *V. cholerae* O1, and whose vibriocidal antibody titres, if drawn, were  $\leq$  640. Other passengers, including those whose illness met

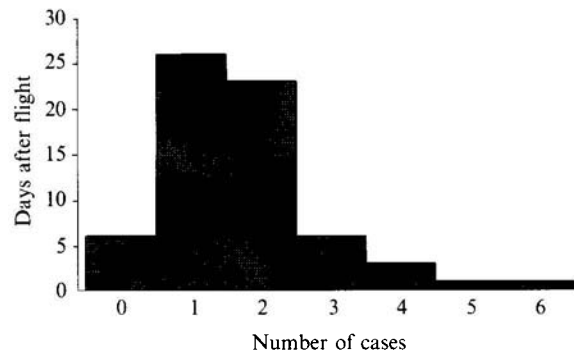


Fig. 1. Onset of gastrointestinal symptoms in 66 passengers with laboratory-confirmed cholera for whom historical data could be obtained.

the CDC case definition of cholera on the basis of diarrhoea and elevated vibriocidal antibody titres, were excluded from the case-control study.

Odds ratios were calculated to examine the univariate relationship between items eaten and culture-confirmed infection. Multiple logistic regression was applied to identify items independently associated with infection [7].

## RESULTS

Of the 336 passengers who landed in Los Angeles, 194 (58%) were located in the United States and submitted laboratory specimens. One hundred (52%) of the passengers had laboratory evidence of infection with *V. cholerae* O1, of which 75 reported diarrhoea, thus meeting the CDC case definition for cholera. Five other passengers on the flight were diagnosed in Japan (Nobumichi Sakai, written communication, 1992). The onset of gastrointestinal symptoms ranged from 0–6 days after arrival (median 2 days) (Fig. 1).

Among the 75 passengers with cholera identified in the United States, 33 were located in Los Angeles County, 24 elsewhere in California, 15 in Nevada, 2 in Arizona and 1 in Hawaii. Fifty-five percent were female. Ages ranged from 9–77 years (median, 45 years). Ten (13%) were hospitalized with cholera, including the only fatal case. Thirty-four had passports from Argentina, 19 from the United States, 17 from Peru, 1 from Italy, 1 from the United Kingdom, 1 from Australia, 1 from Canada, and 1 from an undetermined country.

### Laboratory Investigation

Specimens or isolates from 194 passengers were submitted to CDC: 146 passengers had only serum

Table 1. Proportion of cases and controls who ate selected food items on an airline flight from South America to Los Angeles, February 1992

Food or drink	Cases number (%)	Controls number (%)	OR (95% CI)
<i>(a) Items served between Buenos Aires and Lima</i>			
Raw ham	14/19 (74)	23/50 (46)	3.3 (0.9–12.6)
Cooked ham	13/19 (68)	18/44 (41)	3.1 (0.9–11.6)
Melon	13/19 (68)	26/50 (52)	2.0 (0.6–7.2)
Drink without ice	5/17 (29)	8/46 (17)	2.0 (0.5–8.7)
Bottled water	7/19 (37)	13/50 (26)	1.7 (0.5–6.0)
Iced drink	8/19 (42)	25/48 (52)	0.7 (0.2–2.2)
<i>(b) Items served between Lima and Los Angeles</i>			
Seafood salad	26/30 (87)	27/75 (36)	11.6 (3.3–44.5)
Turkey sandwich	16/29 (55)	21/67 (31)	2.7 (1.0–7.4)
Ham and cheese sandwich	25/31 (81)	42/69 (61)	2.7 (0.9–8.5)
Bottled water	15/31 (48)	20/75 (27)	2.6 (1.0–6.8)
Chicken sandwich	16/31 (52)	22/68 (32)	2.2 (0.9–5.9)
Drink without ice	10/30 (33)	15/74 (20)	2.0 (0.7–5.7)
Cheese	15/31 (48)	30/79 (38)	1.5 (0.6–3.9)
Iced drink	19/30 (63)	43/74 (58)	1.3 (0.5–3.3)
Fresh fruit	5/23 (22)	16/66 (24)	0.9 (0.2–3.1)

specimens submitted, 14 had only isolates sent for *V. cholerae* isolates, and 34 had serum and *V. cholerae* isolates submitted.

Of the 100 passengers with laboratory evidence of infection with *V. cholerae* O1, 52 had only positive vibriocidal titres, 22 had only isolates confirmed as toxigenic *V. cholerae* O1, and 26 had both elevated titres and confirmed isolates. Of the 48 isolates, 34 (71%) were serotype Ogawa and 14 (29%) were serotype Inaba. All isolates were biotype El Tor.

Twenty-two passengers with laboratory evidence of infection reported no diarrhoea. Clinical data were missing for three other passengers with laboratory evidence of infection.

### Case-control study

Thirty-one passenger cases and 79 controls were enrolled in the case-control study. The median age of cases in this study was 54 years (range, 15–77 years) compared with 35 years for controls (range, <1–84 years). Eighty-one percent of cases were female, compared with 47% of controls.

Sixty-one percent of case-passengers had boarded in Buenos Aires, Argentina, and all had seats in economy class. Only three (10%) had eaten raw seafood during the 3 days before the flight, and only one (3%) had purchased a food or beverage from a street vendor during the 3 days before the flight.

Table 2. Logistic regression model for food and drink exposures on an airline flight from South America to Los Angeles, February 1992 (28 cases, 61 controls)

Food or drink*	Adjusted OR (95% CI)
Seafood salad	17.9 (4.0–80.9)
Bottled water	2.0 (0.6–6.1)
Turkey sandwich	1.6 (0.4–6.4)
Chicken sandwich	0.9 (0.2–3.7)
Ham and cheese sandwich	0.6 (0.1–3.1)

\* Items served between Lima and Los Angeles for which univariate odds ratios were > 2.0.

Similarly, 67% of controls had boarded in Buenos Aires, and all but three had seats in economy class. Nine (11%) had eaten raw seafood during the 3 days before the flight, and one (1%) had purchased a food or beverage from a street vendor during the 3 days before the flight.

Among foods and beverages served on the flight, only a cold seafood salad, served between Lima and Los Angeles County, was strongly associated with culture-confirmed infection (odds ratio, 11.6; 95% confidence interval, 3.3–44.5). Other items, including drinks, fruit, ham, water, and cold meat sandwiches, had either no or weak association with infection (Table 1).

The logistic regression model included all items served between Lima and Los Angeles County in

which the Univariate odds ratio was  $> 2.0$ . Items served between Buenos Aires and Lima were not included because they could not account for the infections among passengers who had boarded in Lima. This model affirmed the strong association with the seafood salad, and demonstrated no association with the other items (Table 2).

The seafood salad, prepared by a caterer in Lima, included shrimp, fish, pineapple, eggs and apples. An investigation by Peruvian health authorities into food preparation practices at the caterer's kitchen did not reveal a mechanism of contamination.

## DISCUSSION

This was the largest outbreak of cholera ever associated with a commercial flight and the first associated with the recent epidemic of cholera in Latin America. In 1972 at least 47 passengers developed cholera after a flight between London and Sydney [8]. That outbreak was attributed to cold hors d'oeuvres taken on board in a cholera-affected country.

Although the seafood salad was clearly implicated as the source of transmission in this outbreak, it is not known how it became contaminated. The salad may have been prepared with seafood that had been caught in cholera-contaminated waters and was then inadequately cooked. Other ingredients in the salad may have been unwashed, or washed with contaminated water. Finally, one or more foodhandling errors in the caterer's kitchen, en route to the airport, or on board the flight may have contributed to the outbreak.

The number of cholera cases in the United States linked to this flight exceeded the previous total for imported cases reported since the start of the seventh pandemic of cholera in 1961 [3]. Cases stemming from this flight accounted for nearly three-quarters of the reported cases of cholera in the United States in 1992 [9].

This outbreak highlights the risk associated with eating cold foods prepared in a cholera-infected country. Among 18 outbreaks of gastrointestinal illness associated with airline travel between 1947 and 1984 in which a source of transmission was found, hors d'oeuvres or cold salads were implicated in eight. Other cold foods, such as custard desserts and sandwiches, accounted for six other outbreaks [10]. During 1988, a large outbreak of shigellosis linked to 219 flights of an airline based in the United States was also associated with consumption of cold foods [11].

There were no reported cases of cholera from contact with any of the passengers on this flight. There have been no documented cases of intrafamilial spread of cholera in the United States since 1961 (CDC, unpublished data). Countries with good sanitation and a clean water supply should not expect to see this form of transmission [8].

This outbreak highlights several important preventive measures. Travellers to areas where hygiene and sanitation are inadequate have long been advised to eat only foods that have been thoroughly cooked and are still hot [12]. They also would be well advised to continue such precautions while on airline flights originating from or stopping in such countries. Additionally, commercial airlines should examine the practices of their catering services in cholera-infected countries. They should consider eliminating from their menus cold items prepared in such countries, particularly seafood salads.

It is unlikely that the outbreak epidemic in Latin America will end soon. With thousands of airline passengers dispersing daily from cholera-affected countries, cholera outbreaks could easily occur in the United States or other countries unaffected by the current pandemic. Smaller undetected outbreaks of cholera and other diarrhoeal diseases already may have occurred among airline passengers arriving from Latin America. This outbreak was only detected because of its large size, its severity and because the flight arrived in a country that has been sensitized to foodborne diseases [10]. Health care providers should obtain a travel history and consider cholera in patients with diarrhoea who have travelled from cholera-affected countries. Further outbreaks will only be prevented if passengers and airline carriers alike exercise caution regarding cold in-flight foods prepared in a cholera-affected country.

## Acknowledgements

The authors wish to thank the following staff from the County of Los Angeles Department of Health Services: Shirley L. Fannin, MD, of Disease Control Programs; the staffs of the Acute Communicable Disease Control Unit, the Immunization Program, and the HIV Epidemiology Program; Bob Mosby of the Public Health Investigation Unit; and the Health Center Operations staff. Additionally, the authors thank Ben Werner, MD, and staff from the State of California Department of Health Services.

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