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A Review of Reports to CDC of Travelers Who Flew While Infectious With Pertussis From April 2013 to February 2024

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Abstract

Context: Pertussis is endemic worldwide, and exposure can occur anywhere, including commercial aircraft. Travelers exposed to an infectious person with pertussis may receive post-exposure prophylaxis (PEP) for up to 21 days after exposure to decrease risk of infection. This is accomplished through the identification of infectious travelers and their aircraft contacts (a process called aircraft contact investigation [Air CIs]).

Objective: Describe travelers reported to the US Centers for Disease Control and Prevention (CDC) who flew while infectious with pertussis and outcomes of associated Air CIs.

Design: CDC's Port Health Activity Reporting System (PHARS) was queried to identify reports of travelers who flew with pertussis from April 12, 2013, to February 28, 2024.

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Participants: Index cases (passengers or crew members) with pertussis who traveled on commercial aircraft and their exposed passenger contacts.

Main Outcome Measure(s): Traveler demographics, flight characteristics, outcome data from Air CIs.

Results: Three hundred and eight individuals who recently traveled on commercial aircraft with pertussis were identified. Of the passengers determined to be infectious on the flights, Air CIs were initiated for 102/270 (38%) travelers who flew on 163/500 (33%) flights. Among the 337/500 (67%) flights for which Air CI was not initiated, the most common reason was that the index case was seated adjacent to only household members (142/337, 42%). For flights in which Air CIs were initiated, 234 contacts were identified, and one secondary case in a non-household passenger contact was reported. The average time from when contacts were exposed during the flight to when a health department reported the index case to CDC was 11.6 days (median 10.3 days, range: 0–39 days).

Conclusions: Timely reporting of pertussis cases after air travel may decrease transmission risk to passenger contacts and prevent severe illness.

Keywords

aircraft; air travel; infectious; pertussis; transmission

Introduction

Pertussis is a highly contagious respiratory disease caused by the bacterium *Bordetella pertussis.* It spreads easily from person to person in confined spaces by aerosolization and direct contact with respiratory droplets from infected individuals.[1] The infectious period is defined as the time interval within the first three weeks (21 days) after onset of cough or until at least 3 days of treatment with azithromycin or 5 days with other macrolides has occurred.[1] This vaccine-preventable disease, which remains endemic in the United States (US), can cause illness in people of all ages.[1] Infants less than 6 months old and those with underlying medical conditions are at increased risk of serious complications and death.[1]

After the whole cell pertussis vaccine was initially introduced in the 1940s, the US saw a steady decrease in cases until the 1980s, when this trend reversed and gradual increase, punctuated by multiple epidemic peaks, began.[1] A similar trend has been seen in multiple countries and is thought to be due in part to waning of vaccine induced immunity particularly in countries such as the US that have switched to an acellular pertussis vaccine.[1–5] Although cellular and acellular vaccines both have high effectiveness (~70–90%), acellular vaccine effectiveness is thought to decrease more quickly over time.[1] Waning immunity coupled with low vaccination coverage rates among adults (just over 30% in 2019)[6] compared to children (82% for four or more doses by age 24 months in 2018–2019)[7] and adolescents (89% in 13- to 17-year-olds in 2023) is thought to play a role in increased population susceptibility over time.[8] Thus, despite the widespread use of pertussis vaccines in children and adolescents, thousands of pertussis cases are still reported to the US Centers for Disease Control and Prevention (CDC) each year.[9,10]

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To prevent transmission among individuals who come into close contact with people infectious with pertussis, contact investigations (CIs) are conducted for US permanent residents as well as visitors. During a CI, public health authorities work to identify and notify potentially exposed individuals, or contacts, who can then be offered post-exposure prophylaxis (PEP) to decrease the risk of infection. PEP for pertussis can reduce infection risk if given within 21 days of exposure. Macrolide antibiotics such as azithromycin, erythromycin, or clarithromycin are commonly prescribed for pertussis PEP.[11]

Previous investigations have shown that infections transmissible via air such as pertussis, measles, influenza, and coronavirus are more likely to pose a risk to travelers on airplanes, compared to infections transmissible via direct contact, such as viral hemorrhagic fevers and various types of bacterial gastrointestinal infections.[12–15] For this reason, in the US, health departments (HD), CDC, and airlines collaborate to carry out aircraft contact investigations (Air CIs), for specific communicable diseases including pertussis.

Historically for respiratory pathogens, the default contact zone on airplanes has been defined as passengers who were seated within the same row or within two rows (in front or behind) of the infected index case. The effectiveness of using this default definition has recently come into question.[16] Many public health agencies regularly review the data to ensure current protocols are updated and evidence based. For pertussis, given that transmission likely occurs via larger droplets that are unlikely to spread as quickly or as far through the air, CDC's current protocol defines the contact zone to include only passengers seated adjacent to the index case.

After a HD identifies a traveler who flew while infectious, the HD reports the case to CDC. In accordance with federal regulations, flight manifests are then requested by CDC from the airline to obtain contact information of passengers who may have been exposed. Contact information for close contacts is securely provided to the HD of the state or territory of residence of the contact via Epi-X, CDC's secure data exchange platform. Epi-X functions as a mostly one-way communication channel for Air CIs, wherein CDC sends notifications to HDs regarding identified contacts, but HDs subsequently send outcome data back to CDC via different methods. After receiving contact information, HDs then notify and interview the potentially exposed passenger contacts, recommend PEP if indicated, and voluntarily collect outcome data, such as whether the HD was able to reach and interview the contact, whether the contact received PEP, and whether the contact contracted the disease; these outcome data are then voluntarily reported to CDC. Outcome reports do not consistently include data on when contacts were interviewed during the 21-day post-exposure period in which disease may develop.

When infectious travelers are reported by HDs to CDC Port Health Stations (PHS), the infectious traveler's demographic, clinical, laboratory, and flight itinerary information reported by the HD are entered into CDC's Port Health Activity Reporting System (PHARS), previously called QARS (Quarantine Activity Reporting System), a secure database for managing CDC's border public health activities. Clinical and laboratory data are reviewed by port health medical officers to determine if the ill traveler was infectious during the flight and if an Air CI should be initiated. CDC's criteria for initiating a pertussis

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Air CI include: (1) the traveler is confirmed infected with pertussis by laboratory test or physician's diagnosis; (2) the traveler was infectious at the time of air travel; and (3) the traveler was reported to CDC within one incubation period (21 days) of travel.

There are limited published data available describing individuals who flew while infectious with pertussis and their contacts. This report describes travelers reported to CDC who flew while infectious with pertussis and outcomes of associated Air CIs, as well as the average length of time between exposure of contacts and reports to CDC.

Methods

The PHARS database was queried to identify cases of travelers with pertussis reported to CDC from April 12, 2013, to February 28, 2024. Index cases were defined as passengers or crew members with laboratory-confirmed or clinically diagnosed pertussis who traveled on domestic or US-bound international commercial aircraft while infectious. Passenger contacts were defined as passengers on a flight with an index case who were seated on either side of the case (ie within 3 feet) or across the aisle if the case was in an aisle seat (Figure 1). Individuals seated two seats away were also considered contacts if the adjacent seat was empty. Passengers who were seated within the defined contact zone and were also household members or other co-travelers of an index case were *not* included in the Air CI because they would have already been identified as close contacts of the index case and likely advised to take PEP by local public health authorities.

Index case demographic information including age, sex, flight type (domestic vs. inbound international), and time between flight arrival and when the case was reported to CDC were analyzed. Number of Air CIs initiated and reasons for not initiating an Air CI were also analyzed. Air CI outcome reports were analyzed to identify secondary cases. Because determining immunity to pertussis based on history of vaccination is challenging due to the frequency of boosters required, and the fact that the PHARS database did not capture number and timing of previous doses, vaccination history of travelers could not be accurately captured or reported.

Data analysis and visualizations were conducted using R (v. 4.3.3) in RStudio (v. 2023.12.0 + 369). This activity was reviewed by CDC, deemed not research, and was conducted consistent with applicable federal law and CDC policy.*

Results

CDC received reports of 308 individuals who traveled on an air conveyance with pertussis (599 total flights) during the analysis period. Of these 308 individuals, we excluded 38 passengers who were ultimately determined to not have boarded the flight or not to have been infectious with pertussis during the flight. Two hundred and seventy (88%) were determined to be infectious with pertussis during the flight. Among the 270 cases of travelers who flew while infectious with pertussis and were reported to CDC, the average amount of time that elapsed between the arrival of a flight with an infectious traveler and

*See eg 45 C.F.R. part 46, 21 C.F.R. part 56; 42 USC. §241(d); 5 USC. §552a; 44 U.S.C. §3501 et seq.

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the report of that case to CDC was 11.6 days (median 10.3 days, range: 0 to 39 days), which is within the 21-day window for providing PEP. Of the 270 travelers who flew while infectious, CDC initiated Air CIs for 102 (38%) index cases who flew on 163 flights.

The remaining 168 travelers who flew while infectious on 337 flights did not meet the criteria for Air CI. The top three reasons for not initiating a CI include: (1) index case was seated adjacent to only household contacts (142/337 flights, 42%); (2) index case was reported to CDC after more than one incubation period (21 days) of travel (75/337 flights, 22%); and (3) index case was on an outbound international flight or did not include a US leg (36/337 flights, 11%).

Among the 102 cases for which Air CI was initiated, 49 (48%) were female, 49 (48%) were male, and 4 (4%) had unreported sex; median age was 16 years (range 24 days to 69 years). Of the 163 flights for which Air CI was initiated, 138 (85%) were domestic and 25 (15%) were inbound international. For the 163 flights that met Air CI criteria, 234 air passenger contacts were identified. Of the 234 air passenger contacts identified, 208 Epi-X notifications were sent to health departments. Air CI outcome data were reported back to CDC for 71/208 (34%) contacts (Figure 2). Of the 71 air travel contacts who were reported as interviewed, 7/71 (10%) received PEP and 64/71 (90%) did not receive PEP. Of those who did not receive PEP, 8/64 (13%) were within the window for prophylaxis but declined. Of those who did not receive PEP, 15 (23%) were outside the window for prophylaxis, 6 (9%) were awaiting appointments to see their healthcare provider, 13 (20%) did not receive PEP for other reasons (identified as low risk, PEP not recommended per state protocol, etc.) and 21 (33%) had no information about why PEP was not received. There was one (1%) secondary case identified among air travel contacts.

Discussion

Of the 71 close contacts identified as having been exposed to a traveler infectious with pertussis on a commercial aircraft and with outcome data reported back to CDC, only one secondary case was identified. Reports to CDC on average were made within the 21-day window for PEP to be administered to close contacts. Only 7 of the 71 contacts interviewed were reported as receiving PEP. Given the endemicity of pertussis in the US and other places, exposure on aircraft is likely to continue to occur. Efficient identification of cases and their close contacts allows for timely administration of PEP which decreases transmission risk and risk for symptomatic disease. However, the value of continuing aircraft contact investigations for pertussis is unclear given the low number of secondary cases among interviewed contacts, along with the high risk of exposure in other settings due to the endemicity of pertussis. Ensuring adequate population vaccination rates may be a more effective and efficient way to prevent disease transmission on aircraft.

There are multiple limitations to our analysis. Pertussis is endemic in the US and exposure can occur anywhere, including on commercial aircraft. Pertussis cases are under-reported to CDC for multiple reasons; for example, HDs might have limited resources for timely and complete reporting of cases with airline travel to CDC or the clinical presentation of pertussis infection can vary and individuals who are asymptomatic or have mild symptoms

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might not seek medical attention, or may seek medical attention, but be diagnosed with something other than pertussis if pertussis testing is not pursued. Vaccination status of contacts could not be accurately captured for this dataset, making it difficult to determine whether vaccination status contributed to the low number of identified secondary cases. Also, since household members are not included, secondary cases among household contacts may have been missed. Voluntary outcome reporting by HDs to CDC was low, which may be due in part to HD staffing shortages and limited resources, as well as competing priorities. Finally, HDs may not have followed contacts out for the full 21 days, and secondary cases may have been missed if this occurred. Timely reporting of pertussis cases after air travel may decrease transmission risk to passenger contacts and prevent severe illness; however, overall benefits should be weighed against available resources.

Acknowledgments

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AMG, SM, and SG conceived of this analysis. MK performed quality assurance of data. RMC and JJF did the initial data analysis. LEP supported data analysis. KP led and coordinated the project along with RMC. All authors participated in review of project activities at each step as well as writing and revisions of the manuscript.

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Implications for Policy & Practice

- Continued improvement in collaboration between CDC, airline partners, and HDs may allow for more timely notification of travelers who are identified via the Air CI process, which may in turn allow for more timely and effective PEP administration.
- System improvements that allow for more automated steps in the reporting and notification process may increase efficiency and reporting of outcome data.
- However, even with improvements to the current process, the value of conducting pertussis aircraft contact investigations remains unclear. Additional studies may be useful to determine whether strategies such as increasing population vaccination rates could be a more efficient way to decrease transmission risk during commercial air travel.

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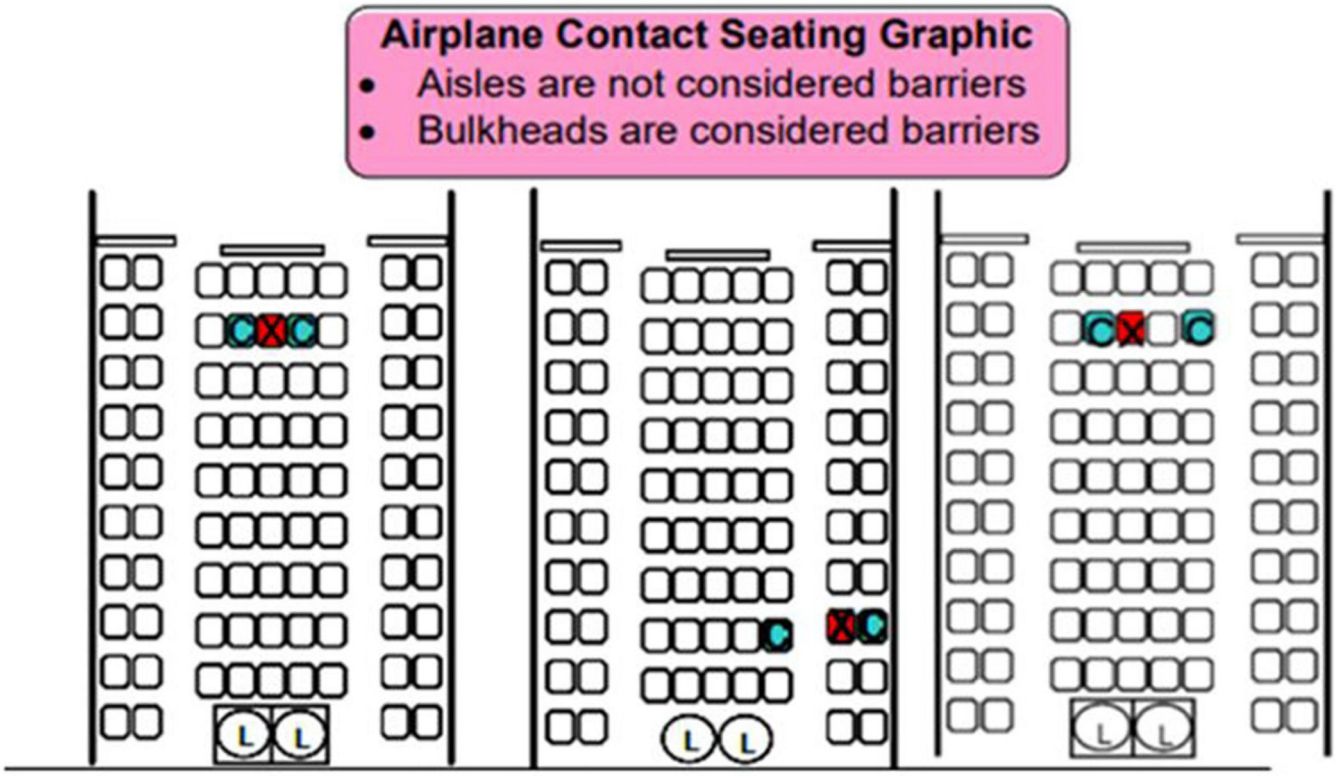


FIGURE 1.

Current Aircraft Seating Chart Demonstrating the Traveler Close Contact Zone Used for Aircraft Contact Investigations for Travelers Who Flew While Infectious with Pertussis and Who Are Reported to CDC*.

*Passengers (denoted by blue squares with a “C”) sitting on either side of the case traveler (denoted by red squares with an “X”), and across the aisle if case is in an aisle seat. If there is an empty seat between the case traveler and another passenger, that passenger is considered a contact (does not apply if empty seat is across the aisle). Applies to all flights regardless of flight duration. Bathrooms are denoted with an “L” inside a circle.

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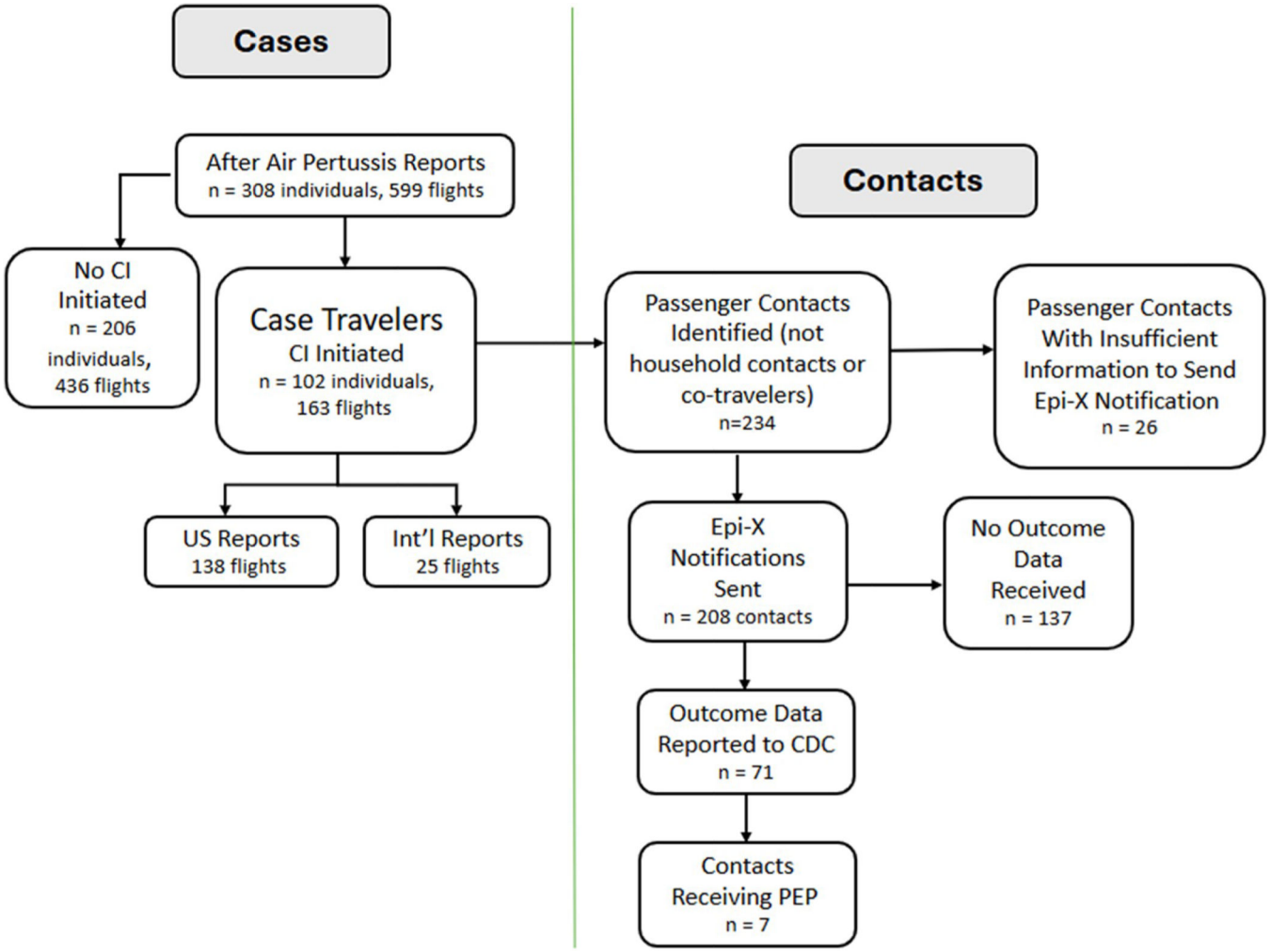


FIGURE 2.

Flow Chart Describing Reports to CDC from April 12, 2013, to February 28, 2024, of Travelers with Pertussis, Associated Flights, and Exposed Passenger Contacts.