

## **AVIATION PUBLIC HEALTH INITIATIVE**

### **Assessment of Risks of SARS-CoV-2 Transmission during Air Travel and Non-Pharmaceutical Interventions to Reduce Risk**

#### **Phase One Report: Gate-to-Gate Travel Onboard Aircraft**

Prepared by the  
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#### **Report Highlights**

This report, from the Aviation Public Health Initiative (APHI), apprises the aviation industry and the flying public on of the risks of SARS-CoV-2 transmission during air travel, with independent, science-based analysis along with strategies and practices to reduce those risks.

**The Finding:** This research substantiates that the layered approach of Non-Pharmaceutical Interventions (NPI) instituted on commercial aircraft - effectively diluting and removing pathogens and in combination with face masks - results in a very low risk of SARS-COV-2 disease transmission on aircraft.

These synergistic layers include:

The onboard ventilation system that continuously circulates and refreshes the air supply, filtering out >99% of the particles that cause COVID-19, and rapidly dispersing exhaled air with displacement in the downward direction. This ventilation effectively counters the proximity travelers are subject to during flights.

Universal wearing of facemasks by passengers and crew throughout the journey;

Distancing protocols during boarding and deplaning;

Disinfection of high-touch aircraft surfaces to remove contamination; and,

Passenger attestations that they do not have COVID-19 related symptoms and commitment to adhere to airline mask policy.

As additional research on the novel coronavirus and new technologies to mitigate risk emerge, the APHI will monitor and report on these developments during the coming months.

## **Background**

The Aviation Public Health Initiative (APHI) combines a team of faculty and associates at the Harvard T.H. Chan School of Public Health, including environmental, infectious disease, medical, industrial hygiene, epidemiological and social scientists. The project grew from interest by the aviation industry to both reduce risks of SARS-CoV-2 disease transmission and safely reinvigorate operations in the midst of the global pandemic. Airlines for America (A4A) and a consortium of aircraft and equipment manufacturers, airline operators, and airport operators sponsor the project. The findings and recommendations presented in this report are the independent conclusions of the Harvard T.H. Chan School of Public Health researchers.

The APHI project takes a systems approach to problem assessment and solution building, engaging a wide scope of key aviation industry constituents. The objective is to form a comprehensive understanding of the intersection between the science informing SARS-CoV-2 transmission and the operations in the aviation environment.

Given COVID-19 restrictions, the APHI team conducted primarily virtual meetings - with limited on-site visits - with aircraft manufacturers, airline operators, airport managers, crewmembers, and government leaders. They reviewed extensive documentation and modeling of disease transmission onboard aircraft. They carefully monitored emerging research on the novel coronavirus. The intent of these efforts is to formulate a broad analysis of options available to mitigate and reduce the risk of SARS-CoV-2 within the aviation system.

The focus of this Phase One Gate-to-Gate report is two-fold: 1) To understand the dynamics introduced by the potential presence of SARS-CoV-2 in the confined space of a commercial passenger aircraft; and, 2) To recommend actions and strategies to reduce and mitigate the risk of SARS-CoV-2 transmission on board the aircraft during cruise as well as boarding and deplaning. The recommended actions and strategies apply to the operators of airlines and rely critically on the behaviors and actions of airline cabin crews, airport employees, cleaning personnel, and individual travelers, who together protect against disease transmission. The Phase Two Curb-to-Curb report on airport operations will be released in approximately two months.

## **The Report**

The APHI Phase One Gate-to-Gate report summarizes the emerging scientific literature on the effectiveness of selected non-pharmaceutical interventions (NPI) used to control transmission of the novel coronavirus SARS-CoV-2 on board aircraft. Based on modeling of aircraft ventilation systems and current evidence about this novel coronavirus, the report presents recommendations regarding risk mitigation for airlines, airline passengers and crewmembers. The comprehensive strategy proposed incorporates layering NPI to create additive and/or synergistic benefits for reducing the risk

of exposure to SARS-CoV-2 during air travel. This layered NPI approach, with ventilation gate-to-gate, reduces the risk of SARS-CoV-2 transmission onboard aircraft below that of other routine activities during the pandemic, such as grocery shopping or eating out.

## **Risks and Risk Reduction**

Research on the SARS-CoV-2 virus is still emerging. The disease spreads through droplets and aerosolized particles. The exact viral dose required for disease transmission is yet unknown. The virus enters the body through mucous membranes in the eyes, nose, and mouth. There is a relatively low risk - approximately 10%, of viral spread through fomites - of surface contaminants. Pre-symptomatic and asymptomatic persons, unaware that they are infectious, shed viral particles and can transmit the novel coronavirus.

Risk reduction of SARS-CoV-2 transmission on an aircraft is a function of a layered approach, with each layer offering additive protections:

- I. **Ventilation Engineering Controls:** Commercial passenger aircraft are equipped with highly effective ventilation systems that refresh cabin air on average every 2-3 minutes, filtering air through High Efficiency Particulate Air (HEPA) filters removing > 99% of particles of the size that cause SARS-CoV-2. Passengers and crewmembers breathe a combination of 50% filtered and 50% fresh outside air.
- II. **Face Masks:** Face masks significantly reduce risks of disease transmission during the COVID-19 crisis, and airlines have established strictly enforced mask-wearing policies. Passengers who do not comply are often times placed on no-fly lists for the duration of the pandemic. Airlines have implemented protocols to manage boarding and deplaning in order to maximize distancing as people move through the cabin.
- III. **Disinfection:** Airlines have instituted cabin-cleaning practices to remove contaminants from high touch surfaces. These cleaning procedures are in keeping with EPA guidelines and cleaning recommendations from manufacturers.
- IV. **Screening:** Passengers and crew provide health attestations to confirm that they are free of COVID-19 symptoms and not exposed to someone who is positive. Nevertheless, pre-symptomatic or asymptomatic people, who are contagious, could be unaware of their condition and continue to circulate in public. This is particularly true for flights originating from locations with a high incidence of cases. Until quick, inexpensive, and reliable airport testing is available, this presents a risk. Appropriate layers of protection - ventilation, face masks, and disinfection – counter this risk.

- V. **Education and Awareness:** Airlines and airports are campaigning to inform the public about actions they can take to reduce disease transmission on their journey. This includes public health safety information while booking, at check-in, boarding, and on the aircraft. Cabin crew receive training to identify and isolate potentially infected individuals should a case appear on board an aircraft.

Since implementing these measures in the spring of 2020, and with millions of passenger hours flown, there has been little evidence to date of onboard disease transmission. Case studies that do find such transmission report data prior to implementation of strict face mask policies. While investigation of the virus and its transmission is ongoing, the research to date indicates a relatively very low risk of acquiring SARS-CoV-2 while flying.

Until there has been widespread vaccination, there remains the risk of infection in all walks of public life. As with any activity during this pandemic, the choice to fly is a personal one and depends on a traveler's health assessment, individual risk tolerance and the potential consequences of becoming infected. When there is a question, especially for individuals at higher risk, consultation with one's health provider before travel and other public activity is recommended.

### **Findings and Recommendations**

The APHI study offers the following findings and recommendations for the "Gate-to-Gate" journey. The recommendations are separated into two parts: I. Airline Actions and II. Traveler Actions.

#### **I. Airline Actions**

##### **a. Ventilation Systems**

###### *Finding*

During boarding and deplaning, passengers stand to move on/off the plane, and to store/retrieve overhead luggage. This puts people in closer proximity to other passengers than when seated in rows, and when facing the seat back in front of them. The highly effective ventilation systems, operational when the plane is cruising, should be operated always when the plane is on the ground.

###### *Recommendations*

1. Ensure consistent operation of ventilation systems during flight. The highly efficient ventilation systems engineered into modern passenger aircraft effectively protect against disease exposure when airborne by rapid and continuous filtering and exchange of cabin air.
2. Extend in-flight level ventilation while on the ground: Supplementary ground-based ventilation systems must be operated in accordance with ICAO (International Civil Aviation Organization,

United Nations) and manufacturers' guidance to ensure appropriate and sufficient ventilation is maintained throughout the boarding and deplaning processes.

## **b. Disinfection Protocol**

### *Finding*

There is very low probability of being infected with SARS-CoV-2 via fomites in the aircraft cabin. Since the onset of the COVID-19 crisis, the airlines' disinfection processes have dramatically increased in frequency and intensity, reducing the indirect spread of infection through contaminated surfaces inside the cabin. Airlines have specifically added additional procedures to prioritize the disinfection of high-touch surfaces between flights, and deeper cleaning and disinfection overnight or when there is enough time between flights, or "turns."

### *Recommendation*

Maintain current practices.

## **c. Physical Distancing During Boarding and Deplaning**

### *Findings*

Onboard distancing, during boarding and deplaning, present risks to potential transmission during air travel, due to the proximity of people standing and moving. This includes queuing on the jet bridge leading from the gate to the aircraft.

Physical distancing is difficult to accomplish in the boarding and deplaning processes, as passengers locate or leave their seat and they place or retrieve luggage. Many, though not all airlines have implemented row-by-row seating and deplaning. However, passengers who impatiently stand up and loiter in the aisle are a problem for aircraft crew seeking to manage orderly, distanced sequences of activity.

### *Recommendations*

1. Reduce the density of passengers embarking/d disembarking the jet bridge at any one time. With physical markings on the floor, passengers will be encouraged to maintain appropriate physical distancing, just as many people have become accustomed to these practices at grocery stores and other public venues.
2. Admit limited numbers of passengers on the plane at one time and in row-by-row sequence, so passengers can systematically locate and take their seats before other passengers come up

behind them. The process should be overseen by flight attendants during deplaning, as passengers stand in sequence to depart the aircraft.

3. Maintain appropriate ventilation during all phases of travel, including while the plane is on the ground.

## **II. Traveler Actions**

### **a. Policies and Procedures**

#### *Findings*

In alignment with current scientific understanding of COVID-19, airlines in the United States have adopted policies and procedures requiring compliance with behaviors to mitigate spread of SARS-CoV-2 on board aircraft. Those who violate these policies and procedures are placed on a no-fly list and will be barred from flying on the airline until after the COVID-19 crisis. This enforcement is a powerful motivator to achieve passenger behavioral compliance, and it is essential for achieving consistent risk reducing and public health-protecting behaviors during flight.

#### *Recommendations*

For prospective passengers, measures that reduce risks of disease transmission enhance confidence in their safety from COVID-19 and serve as a factor in the decision to fly. Therefore, actions by the airlines to require compliance with risk-reducing health measures are an important factor for people considering air travel.

### **b. Face Masks**

#### *Finding*

Face masks without exhalation valves or vents or other openings are a critical element in preventing the spread of respiratory infectious diseases while traveling. In fact, face mask requirements are perhaps the most essential layer of a comprehensive set of measures to reduce transmission of COVID-19 throughout air travel.

#### *Recommendations*

1. Passengers and airport/airline employees should be required to wear face masks throughout their air travel journey – including time spent in the airport, boarding, in-flight, in lavatories, and deplaning.

2. Removing masks to eat or drink should be kept to an absolute minimum, in order to maintain the significant protections afforded by universal face mask wearing. Use straws when feasible.
3. When one passenger briefly removes a mask to eat or drink, other passengers in close proximity should keep their masks on.

## **Conclusion**

This investigation finds the risk of SARS-CoV-2 transmission on an aircraft is reduced to very low levels through the combination of layered infection control measures.

Implementing the layered risk mitigation strategies described in this report requires passenger and airline compliance. It will help to ensure that air travel, with respect to SARS-CoV-2 transmission, is as safe or substantially safer than the routine activities people undertake during these times. As such, this layered approach, with ventilation gate-to-gate, reduces the risk of SARS-CoV-2 transmission onboard aircraft below that of other routine activities during the pandemic, such as grocery shopping or eating out.

The findings and recommendations in this report offer the public the opportunity to reach informed decisions about air travel. Technical and scientific evidence form the foundation of the findings and recommendations.

Though a formidable adversary, SARS-CoV-2 need not overwhelm society's capacity to adapt and progress. It is possible to gain a measure of control and to develop strategies that mitigate spread of the disease while allowing a careful reopening of sectors of society. There is much to gain by simply following the science. It offers a bounty of information about how people can achieve both safety and opportunity.

For more information and updates issued by the Harvard T.H. Chan School of Public Health, Aviation Public Health Initiative:

<https://npli.sph.harvard.edu/crisis-research/aviation-public-health-initiative-aphi/>