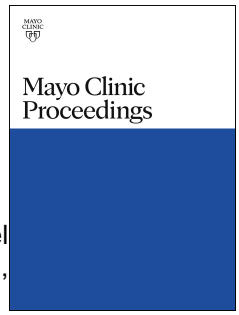

SARS-CoV-2 Testing Prior to International Airline Travel, December 2020-May 2021

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SARS-CoV-2 Testing Prior to International Airline Travel, December 2020-May 2021

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Abstract

While there have been several case reports and simulation models of SARS-CoV-2 transmission associated with air travel, there are limited data to guide testing strategy to minimize the risk of SARS-CoV-2 exposure and transmission onboard commercial aircraft. Among 9,853 passengers with a negative SARS-CoV-2 PCR performed within 72 hours of departure from December 2020 through May 2021, five (0.05%) passengers with active SARS-CoV-2 infection were identified with rapid antigen tests and confirmed with rapid molecular test performed before and after an international flight from the United States to Italy. This translates to a case detection rate of one per 1970 travelers during a time of high prevalence of active infection in the United States. A negative molecular test for SARS-CoV-2 within 72 hours of international airline departure results in a low probability of active infection identified on antigen testing during commercial airline flight.

Abbreviations:

SARS-CoV-2, severe acute respiratory syndrome coronavirus 2; US, United States; ATL, Hartsfield–Jackson Atlanta International Airport; JFK, New York John F. Kennedy International Airport; FCO, Rome–Fiumicino International Airport; MXP, Milan Malpensa Airport; CDC, US Centers for Disease Control and Prevention; COVID-19, coronavirus disease 2019; PCR, polymerase chain reaction;

Introduction

Published case series have raised concerns for risk of SARS-CoV-2 transmission onboard commercial flights,[1] although the overall frequency of transmission is thought to be low, [2,3] and the summarized data suggest that mass transmission events occur predominantly when masking is not in place.[4] The increased availability of rapid diagnostic testing provides a strategy to identify cases of early or asymptomatic infection, and hence, enhance the safety of airline travel by lowering the risk of an infected person from boarding a flight. The optimal approach to pretravel testing has not been defined and real-world results have not been reported.[5] The feasibility and scalability of a testing strategy is important when considering the historic volume of airline travel in the US (28,000 flights carrying 2.9 million passengers per day in 2019) and the trajectory of the global pandemic.[6] We sought to analyze the observed results of a routine SARS-CoV-2 testing approach prior to international commercial flights during a period high infection burden in the US.

Methods

Delta Air Lines began a pilot program for flights departing from airports in Atlanta (ATL) (beginning December 19, 2020) or New York City (JFK) (beginning April 1, 2021) and arriving in Rome (FCO)or Milan (MXP), Italy. Mayo Clinic and Delta, along with the Georgia Department of Health (with consultation with the CDC), collaborated to review and model various testing strategies for feasibility, false-positive rates, and case detection rates (**Table 1**). Based on the available data, and in agreement with the Italian government authorities, a testing protocol was put in place that would allow passengers to avoid quarantine upon arrival to Italy

(**Figure**). At the time of check-in for an originating flight, passengers were required to attest to the absence of symptoms of COVID-19. Upon arrival to the ATL or JFK connecting airports, passengers were required to provide documentation of a negative molecular test result for SARS-CoV-2 obtained within 72 hours of their departure date as a prerequisite in order to receive a boarding pass. After going through security, passengers at the ATL or JFK airports underwent a rapid antigen test (BinaxNOW). At the time of testing, the test administrator screened passengers for symptoms of COVID-19 and conducted temperature measurement prior to testing. Passengers with a positive antigen test underwent a subsequent rapid molecular test (Abbott ID Now). Passengers testing positive by both the rapid antigen and molecular tests were considered true positives and infected with SARS-CoV-2 and were not allowed to board the aircraft. Passengers with a negative antigen test, or those testing positive by rapid antigen but negative by the confirmatory molecular test (false-positive rapid antigen) were permitted to board the aircraft. Upon arrival in Italy, all passengers were tested again using a rapid antigen test (STANDARD Q COVID-19 Ag, SD BIOSENSOR, Suwon-si, South Korea), with any positives being confirmed by molecular testing (Bosch Vivalytic, Bosch Healthcare Solutions, Waiblingen, Germany). Passengers testing positive by rapid antigen test were moved by the Italian Ministry of Health to the designated COVID-19 hotel or their domicile to wait for their results. If the confirmatory PCR test was positive, the passenger remained in quarantine per Italian regulations. This testing strategy was chosen to provide the best accuracy and to mitigate disruptions to passengers who test positive at airport and were connecting through ATL and JFK airports.

Results

From December 19, 2020 through May 19, 2021, a total of 9,853 potential passengers underwent testing at ATL (n=5,357) and JFK (n=4,496) airports. During the study period, the average community infection prevalence rate was estimated at 1.1%.[7] Among the 9,853 potential passengers who underwent testing in the United States, there were 4 (0.04%) individuals who tested positive by both the rapid antigen and confirmatory molecular tests (**Table 2**). There were no false-positive rapid antigen tests. The average processing time for each test performed at the airport in the United States was approximately 20 minutes per passenger. There were 9,849 passengers who completed travel to Rome (7112, 72.2%) or Milan (2737, 27.8%), Italy, across 129 flights. The average number of passengers on each flight was 76, with an average seating capacity of 289 and load factor of 26%. Testing on arrival in Italy identified 1 (0.01%) additional infected individual (i.e., positive by both rapid antigen and confirmatory molecular) and 12 (0.12%) false-positive rapid antigen tests. When considering a true-positive case as any positive antigen confirmed with molecular test in the airport in either the US or Italy, the prevalence of active infection at the time of travel would have been 1 in 1970 passengers if testing at the airport had not been performed. Previously published literature of the BinaxNow and STANDARD Q COVID-19 rapid antigen testing in asymptomatic individuals suggest a percent sensitivity/specificity of 35.8/99.8 and 69.2/99.1 compared to laboratory-based PCR testing, respectively.[8,9] When used in sequence, we estimate the risk of a false-negative antigen test is 0.00009, using the bayes formula for each test and estimating the risk of a false-negative at each time point conditional on the result of the first test.

Discussion

The COVID-19 pandemic has resulted in a marked reduction in air travel, which has significantly impacted the airline industry. To promote recovery and to reestablish confidence in the commercial airline industry, Delta Air Lines, Mayo Clinic, and the Georgia Department of Health (after consultation with CDC) sought to develop a multipronged strategy including testing to mitigate the risk to travelers. In this analysis of individuals traveling internationally on a commercial airline flight, it was observed that a single molecular test performed within 72 hours of initial departure led to a frequency of active infection of < 1 in 1,000 passengers identified on rapid antigen testing at the airport. This occurred despite an average community infection prevalence rate estimated at 1.1%.[7] These data suggest that even at this higher level of active community infection, a single molecular test performed within 72 hours of departure can decrease the rate of active infection on board a commercial aircraft to a level that is several orders of magnitude below active community infection rates. The addition of other interventions, including universal masking at the airport and onboard aircraft, increase in frequency of air exchanges and enhanced clearing, physical distancing during deplaning activities, increasing vaccination rates among travelers and exclusion of symptomatic individuals, further enhances safety.[10] The results from this study also showed a low yield of additional rapid antigen testing at the airport, suggesting this additional testing is unlikely to add safety alongside other mitigation efforts (i.e., masking) especially as vaccination rates are rapidly increasing. These results occurred during a time in which vaccination rates were much lower in the U.S., which may further influence the impact of testing.

Our analysis is subject to several important limitations. First, we cannot determine whether the knowledge of airport testing requirements alone had a deterrent effect on individuals

with a recent high-risk exposure or who were likely to have infection, providing an additional benefit beyond simply the test itself. The testing protocol itself and the possibility of being unable to complete the travel from Atlanta or New York (for those passengers originating elsewhere) may have selected individuals who perceived themselves at lower risk of COVID-19. This possibility may limit the generalizability of our findings and recommendations to the overall population of commercial air travelers. Second, the initial testing at each airport was performed with a rapid antigen test, which has a lower analytic sensitivity than molecular testing. It is, therefore, possible that there were additional individuals with active SARS-CoV-2 infection with false-negative rapid antigen airport testing. This may explain the passenger who tested positive in Italy, despite a negative rapid antigen test in the United States. Finally, our study did not assess the impact of this testing strategy on subsequent infection in the destination country. A simulation study suggests that even with testing prior to travel, an abbreviated post-travel quarantine should be considered when traveling from high-to-low incidence countries to avoid imported infections.[5]

During a period of high COVID-19 infection burden within the United States, a single SARS-CoV-2 molecular test performed within 72 hours of departure lead to a low percentage (0.05%) of airline passengers identified with active SARS-CoV-2 infection on rapid antigen testing during travel. These data may inform future recommendations for testing during travel.

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Table 1. Testing strategies considered for international travel pilot program.

Testing strategy	Estimated infectious prevalence during flight	Estimated False-Positive Rate	Estimated number of infections detected per 100,000
A. No Testing	0.2%	N/A	N/A
B. 72-hour pre-flight molecular test; rapid antigen at airport, confirm positive antigen tests with molecular test [a]	0.04%	0.5% for molecular test; 10% for antigen test	160 at 72-hour prior; 42 at airport
C. 72-hour pre-flight molecular test; Molecular test at airport	0.015%	0.5% for molecular test	160 at 72-hour prior; 72 at airport
D. Antigen only at airport	0.08%	10%	110
E. Molecular test only at airport	0.03%	0.5%	195

[a] Testing strategy B was chosen for implementation.

Table 2. Infections identified through testing performed at US or Italian airports, presented with number of passengers and frequency of infections per 1000 passengers.

Month	Passengers completing travel	Infections identified	Infections identified per 1000 passengers
December	359	0	0
January	893	1	1.1
February	937	2	2.1
March	960	0	0
April	2788	2	0.7
May	3912	0	0

Figure Legend. Testing algorithm used for flights from the United States to Italy as part of a pilot SARS-CoV-2 testing program.