Shoreland

In-flight Transmission of SARS-CoV-2: What We Do and Don't Know

ESAM Webinar 15/1/2021

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Outline for Today

- Why the absence of large numbers of published in-flight transmissions is not definitive evidence of safety.
  - All peer-reviewed and public health publications of flights with possible transmission were reviewed and categorized
- Engineering angle: aerosol dispersion; flight simulations (newly revised Transcom data)
- WHO policies on testing and vaccination for air travel
- International Ports of Entry, quarantine, testing current landscape
- Digital health passport development
- Summary of layered NPI for air travel

In-flight Transmission: Really Hard to Prove

- <20 peer-reviewed and public health publications of flights with possible SARS-CoV-2 transmission are available
  - Absence of evidence is not evidence of absence.
- Significant pre-symptomatic and asymptomatic transmission
  - Secondary cases that may remain asymptomatic even with a 14-day follow-up
  - Secondary cases may present in as few as 3 days postflight and excluded.
- Person-to-person transmission in individual cases poorly investigated.
- To prove in-flight transmission, ALL pax need to have PCR testing on arrival, quarantine 7-14d, re-test at end of quarantine
  - Most industrialized countries are aware of thousands of domestic narrow-body flights with COVID-19 cases aboard, but contact tracing combined with testing of all at-risk passengers for every index flight has not been possible.

Full Details and References

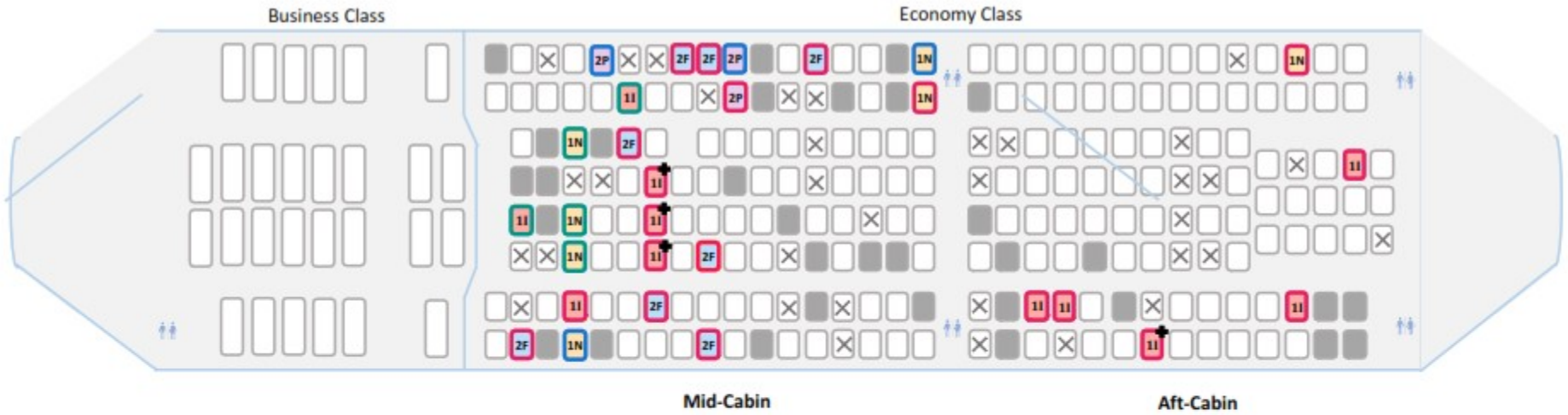
- Freedman DO, Wilder-Smith A. In-flight Transmission of SARS-CoV-2: a review of the attack rates and available data on the efficacy of face masks.
- *J Travel Med, taaa178, https://doi.org/10.1093/jtm/taaa178*

Indisputable Evidence of Mass Transmission

Large outbreak on Ruby Princess cruise ship. Almost no local transmission in Australia on date of flight with disembarked passengers	19-March QF 577 Sydney-Perth A330. 28 Pax in business; 213 in economy	13 PCR+ symptomatic index cases came directly from the Ruby Princess. 9 classified as infectious during flight	11 certain transmissions no other plausible exposures	After initial index cases identified, other PAX notified to quarantine. Testing only of those coming forward. 11 Ruby Princess index cases had the same strain not previously recorded (A2-RP) by WGS	Secondary cases all within 12 rows in the mid-cabin 3 secondary cases more than 2 rows away from a primary case	Rare masking-mass transmission	Proven by WGS. Likely underestimate as no systematic post-arrival testing of asymptomatic flight Pax. Unique sequence likely originated on ship. U.S. passengers on flight had just arrived in Sydney. 5 other primary cases on flight from other ships had different sequences.

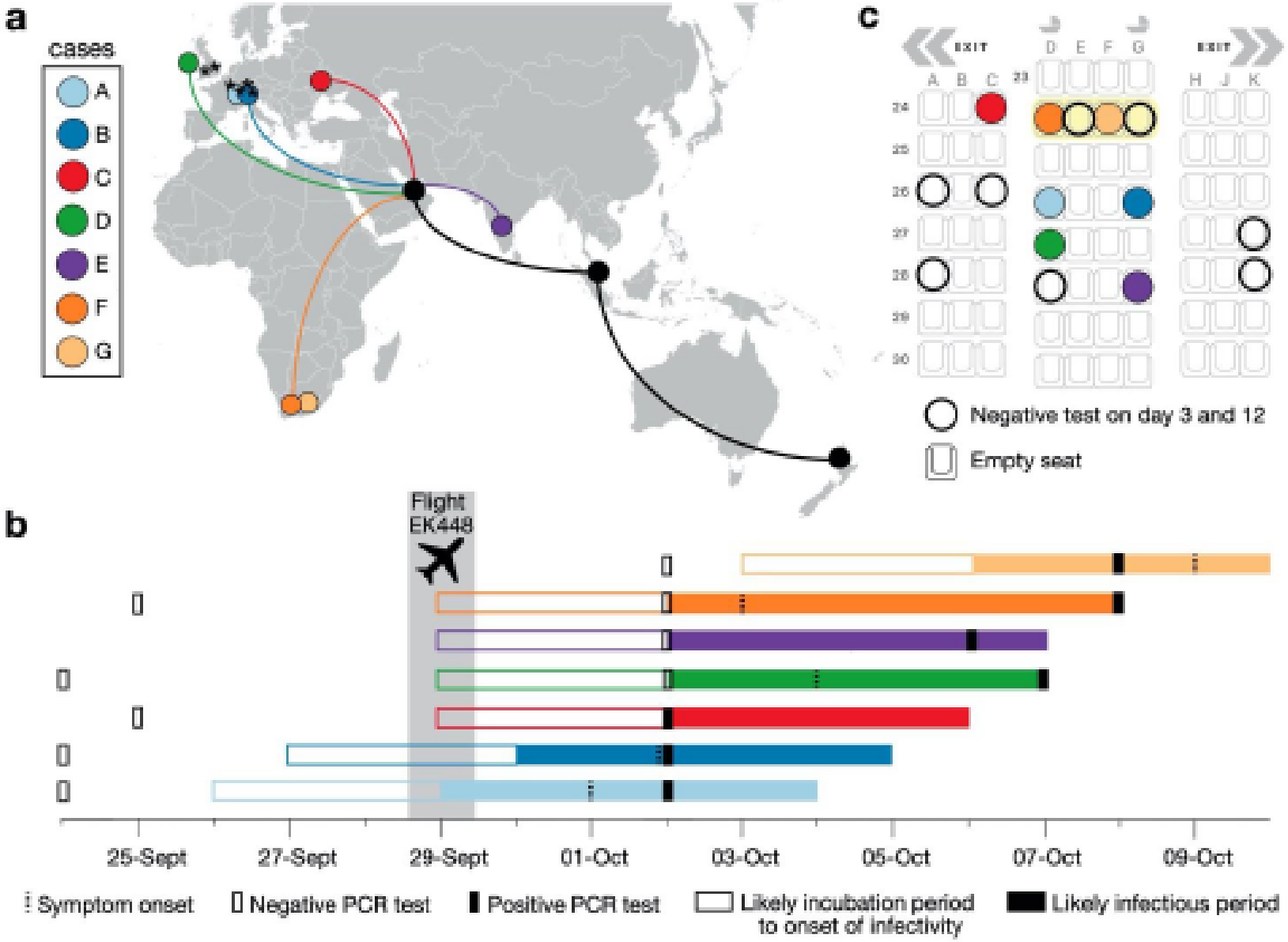
Speake, H Phillips A, Chong, T et al. Flight-associated SARS-CoV-2 transmission from cruise ship passengers during a medium-haul Australian domestic flight supported by whole genome sequencing. *Emerg Infect Dis.* 2020 Dec;26(12):2872-2880.

QF577 19-March

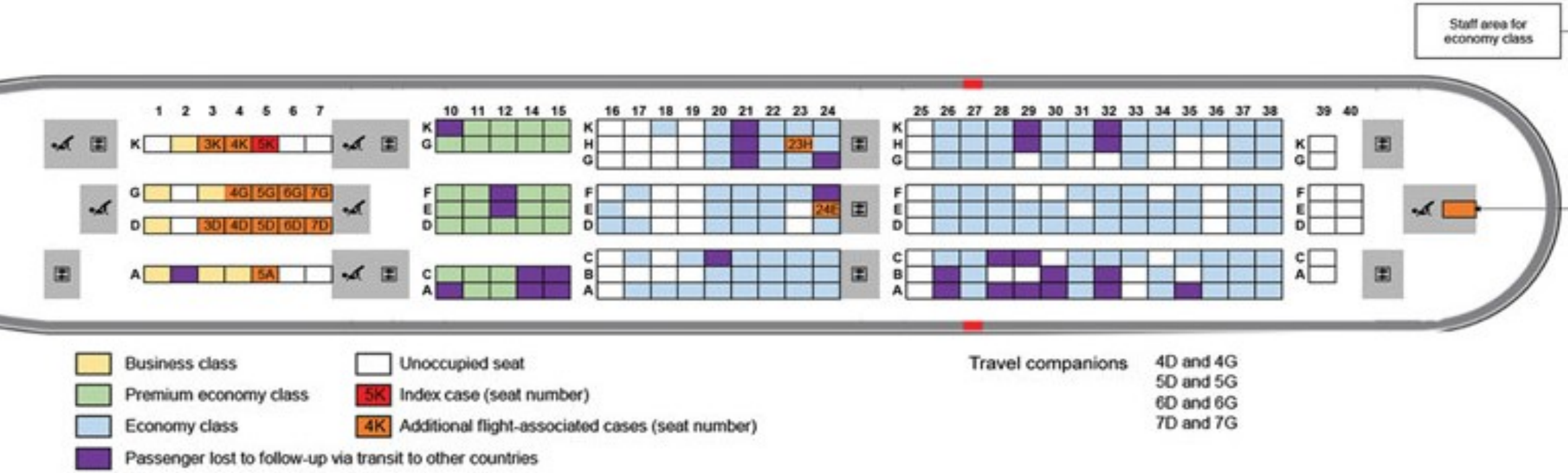


Robust genetic data from NZ (*Emerg Infect Dis*. https://doi.org/10.3201/eid2703.204714)

- After an 18-hour flight from Dubai to Auckland in late September, 7 of 86 passengers on board tested positive for SARS-CoV-2 during the mandatory 14-day quarantine.
- By WGS, all isolates were 100% identical; a unique mutation was found in all isolates that had only been previously reported from 2 countries in Western Europe.
- All infected passengers were seated within 2 rows of the likely index case who was traveling from Europe. All 4 certain secondary cases originated from separate countries outside of mainland Europe, had negative PCR on day 3, and had positive PCR by day 9.
- Instructive elements of this flight are ample spacing (86 of 354 seats occupied); masking in 5 of 7 infected passengers (including the index case) on an air carrier that emphasizes masking; testing, which showed that 5 of 7 cases (including the index case) had negative PCR tests from specimens taken within 72 hours prior to departure; and timing of the flight date, which was in the fall compared to the spring (when most other reported flights with transmission occurred); these standard layers of protection appear to have been ineffective in this case.
- Anecdotal information from IATA of APU off (no ventilation) during refueling in Kuala Lumpur


a
cases
A
B
C
D
E
F
G
c
EXIT
EXIT
A B C
D E F G
H J K
Negative test on day 3 and 12
Empty seat
b
Flight
EK448
25-Sept
27-Sept
29-Sept
01-Oct
03-Oct
05-Oct
07-Oct
09-Oct
Symptom onset
Negative PCR test
Positive PCR test
Likely incubation period
to onset of infectivity
Likely infectious period

VN54 2-Mar


Staff area for economy class
1 2 3 4 5 6 7
10 11 12 14 15
16 17 18 19 20 21 22 23 24
25 26 27 28 29 30 31 32 33 34 35 36 37 38
39 40
K
G
H
F
E
D
C
B
A
3K 4K 5K
4G 5G 6G 7G
3D 4D 5D 6D 7D
5A
23H
24E
Business class
Premium economy class
Economy class
Passenger lost to follow-up via transit to other countries
Unoccupied seat
5K Index case (seat number)
4K Additional flight-associated cases (seat number)
Travel companions
4D and 4G
5D and 5G
6D and 6G
7D and 7G

Possible Transmission with Weak Evidence

- **24-Jan:** Singapore- Hangzhou B787 335 Pax
- **24-Feb:** AF775 Bangui-Yaounde
- **27-Feb** Tel-Aviv-Athens 164 Pax
- **9-Mar:** Tel-Aviv-Frankfurt B737 102 Pax
- **30-Mar:** CI 11 JFK-Taipei 340 Pax
- **Summer** Doha-Dublin 200 Pax
  - **masking**
    - 2 symptomatic index cases and five reported secondary cases
    - Designated secondaries had 1st PCR 4-7 days after flight so could have been infected pre-flight
    - Other flights in series had no systematic testing of passengers only contact tracing

Contents lists available at ScienceDirect

Travel Medicine and Infectious Disease

journal homepage: www.elsevier.com/locate/tmaid

Brief report

In-flight transmission of COVID-19 on flights to Greece: An epidemiological analysis

A. Pavli [a], P. Smeti [a], S. Hadjianastasiou [a], K. Theodoridou [b], A. Spilioti [a], K. Papadima [c], A. Andreopoulou [c], K. Gkolfinopoulou [d], S. Sapounas [e], N. Spanakis [f], A. Tsakris [f], H. C. Maltezou [h,*]

[a] Department of Travel Medicine, National Public Health Organisation, Athens, Greece
[b] Department of Microbiology, Andreas Sygros Hospital, National and Kapodistrian University of Athens, Athens, Greece

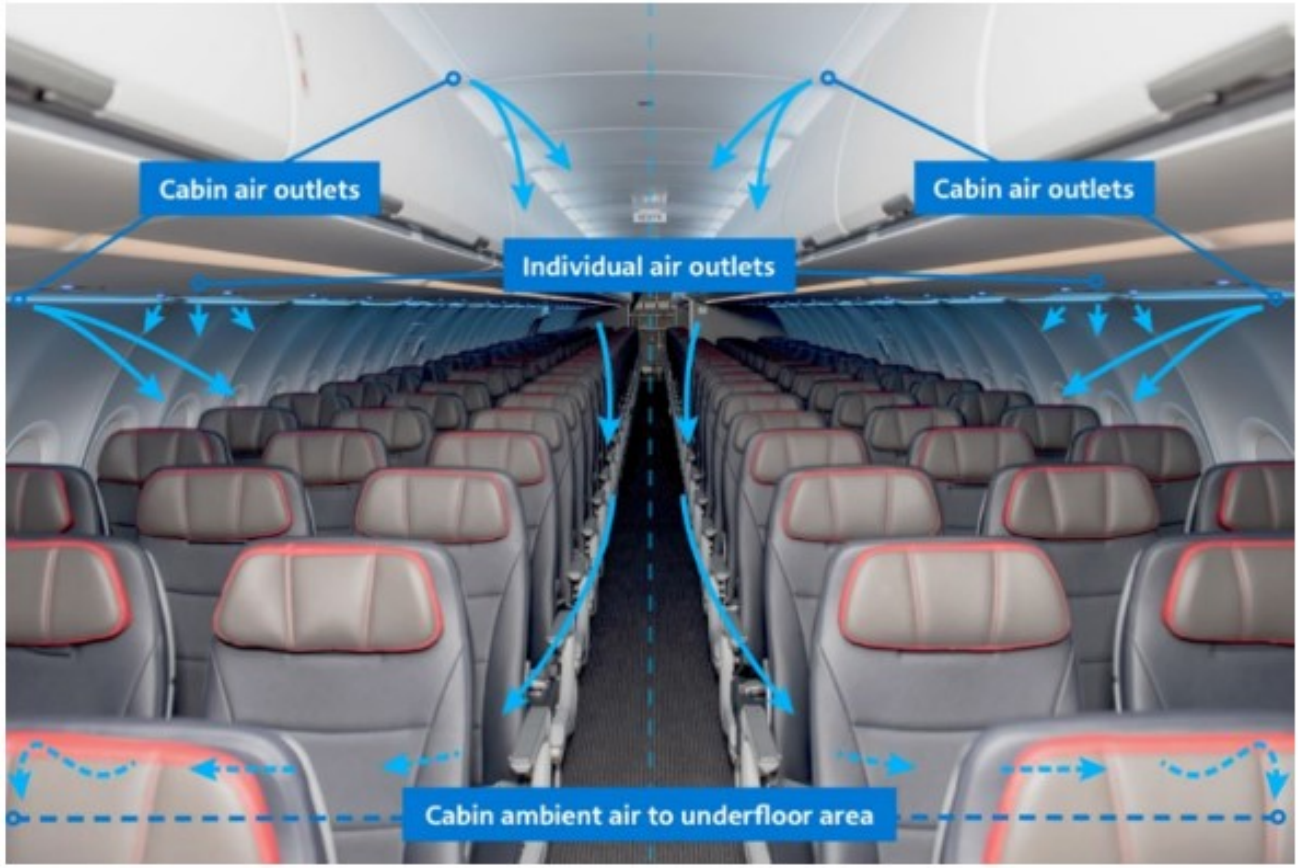
Hong Kong Database can rule out transmission on many flights-must be manually searched

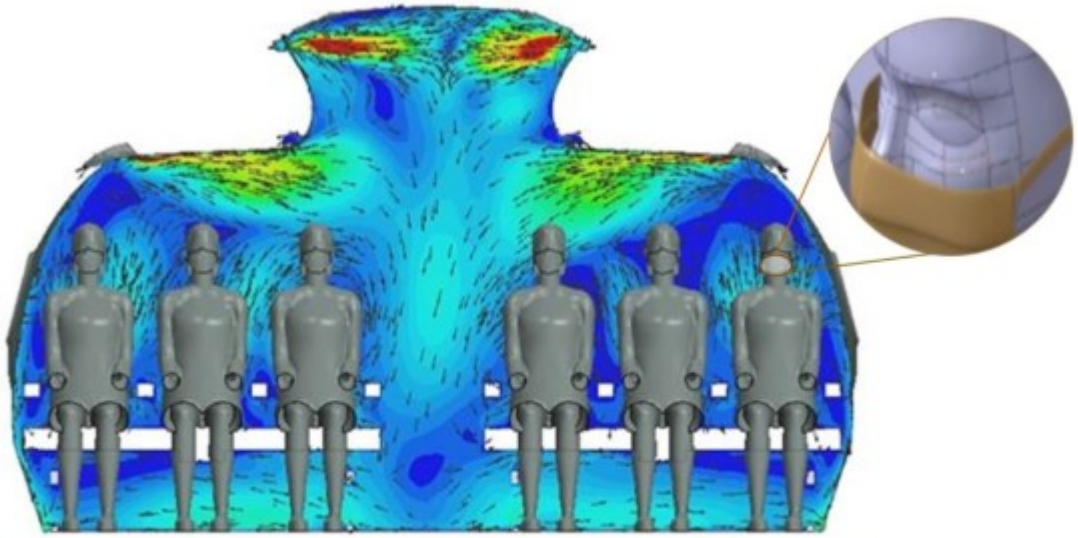
Almost all Pax originated in Pakistan during peak of transmission.	16, 21, 23-June and 3,4-July (5 flights) EK380 Dubai-Hong Kong B777. Unknown Pax# per flight. 360 seats available per flight	10, 19, 13, 9, 7 PCR+ on arrival. 0, 1, 4, 1, 0 symptomatic on arrival; rest asymptomatic.	No transmissions on any of the 5 flights	Observed quarantine with testing on D0, D14		Masking mandatory – no transmission was documented with robust testing of all Pax at D14. Meals served.	All Pax had passed temperature and symptom screening in Dubai 4 hours earlier

Clustering and Masking

- The 3 major, and best documented in-flight transmission events had clear case clustering
- On 3 flights with mass transmission, masking was not mandated
- On 2 flights (NZ, Ireland) with mass transmission, masking was mandated
- On one Emirates flight with 25 passengers PCR+ on arrival but with rigid masking there were only 2 transmissions
- On 5 Emirates flights with the rigid masking policies (meals served) no secondary cases were identified on Day 14 screening
  - A total of 58 passengers who were PCR+ and 1500-2000 other passengers
- In-flight masking mandatory in Canada on June 4 and in Australia on July 22. Even with incomplete contact tracing aggregate figures on in-flight transmission before and after masking would be informative.

Primer on Cabin Air Flow-It Does Work as Advertised





High quality full **3D Computational Fluid Dynamic models** of cabin air flow, **correlated with aircraft test-data** and physical ground tests

Figure 10.3 High-quality Full 3D CFD Models of Cabin Air Flow (Courtesy of Airbus Corp.) (IATA, 2020b)

TRANSCOM/AMC Commercial Aircraft Cabin Aerosol Dispersion Tests

Submitted To:
United States Transportation Command (USTRANSCOM) &
Air Mobility Command (AMC)

https://www.ustranscom.mil/cmd/docs/TRANSCOM%20Report%20Final.pdf

Aerosol tracer testing in Boeing 767 and 777 aircraft to simulate exposure potential of infectious aerosol such as SARS-CoV-2

Sean M Kinahan[1,2]1*, David B Silcott1[3], Blake E Silcott[3], Ryan M Silcott[3], Peter J Silcott[3], Braden J Silcott[3], Steven L Distelhorst[2], Vicki L Herrera[1], Danielle N Rivera[2], Kevin K Crown[2], Gabriel A Lucero[2], Joshua L Santarpia[1,2]

Transcom Study Results

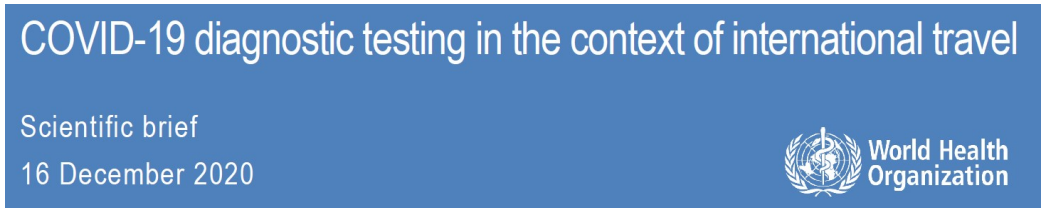
- Mannequins expelling simulated 1 μm fluorescent virus particles simulating quiet breathing while seated were used to determine how the virus spreads as an aerosol.
  - Original report assumed production of 4,000 infectious virus particles per hour/infectious dose for humans of 1,000 virions to estimate a numerical risk. At this time assumptions can't be substantiated simply not known. No risk conclusions in current version.
- 777 airframe economy, a minimum reduction of 99.54% of 1 μm aerosols (no other size tested) from the index source to the breathing zone of a typical passenger seated directly next to the source.
- 767 airframe economy, a minimum reduction of 99.90% in adjacent seat. 767 business class, a minimum reduction of 99.94% in adjacent seat.
- Seats forward and aftward by 1 to 2 rows generally had reduction in penetration percentage of more than 99.98%, increasing with distance.
- Airflow tended to be slightly aftward in the 777 and forward in the 767.
- DNA-tagged 3 μm aerosols contamination of surfaces was negligible

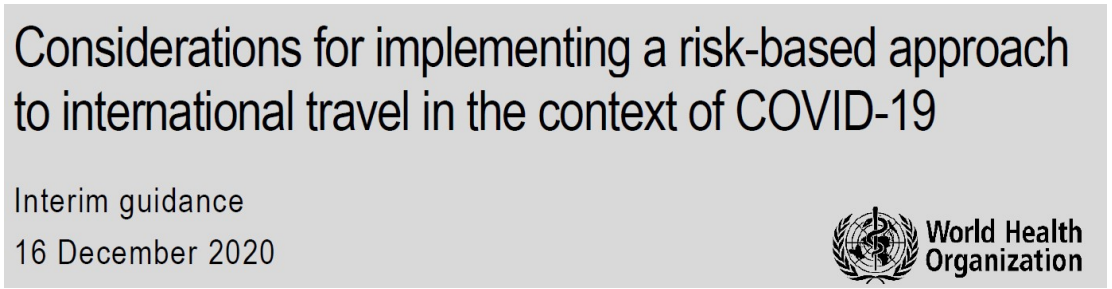
Transcom Study Limitations

- Conclusions are based on seated passengers only and do not account for the number of infectious passengers on board, boarding/deplaning, eating, talking, lavatory visits, exposure to flight attendants, or pre- or postflight exposures.
- Assumption that larger droplets cannot play a role in transmission onboard.
- Full ECS used. Air flow is significantly reduced at the gate, during gate delays, pushback/tow-in, or runway waits when ground units or APUs of various capabilities are intermittently in use; specific data in those situations is stated to be part of another manuscript.
- A single precise aerosol mitigation number not possible. Airframe variability.
- The assumptions include that few coughing passengers would make it on board, but several experiments indicated that a surgical-grade mask provided 15% additional protection against coughed 1 μm aerosols
- Gaspers open versus closed made no difference, and aisle, middle, or window seats were equivalent (aisle traffic was not simulated). This data only in original version.
- The results are reassuring that airflow patterns function as designed in well-maintained wide-body aircraft used for long-haul travel.
  - No data here on smaller or poorly maintained aircraft
- Further studies must account for the many elements of human behavior before, during, and after the flight.

WHO and International Travel High Level View

- Travelers should not be tested, vaccinated (health equity issue), required to have any sort of immunity certificate, nor be quarantined as a condition of entry or exit.
- WHO rationale
  - at current high levels of transmission in essentially every country, no evidence exists for a public health impact of testing or vaccination of travelers on transmission or public health in the receiving country.
- Health of individual travelers is secondary to public health considerations
- International travelers should not be considered by nature as suspected COVID-19 cases or contacts.
- Thus, no present WHO/IHR guidance or standardization for apps documenting vaccination or testing status (IATA Travel Pass, CommonPass, AOKpass, IBM Digital Health Pass etc)





https://apps.who.int/iris/rest/bitstreams/1322899/retrieve
https://apps.who.int/iris/rest/bitstreams/1322864/retrieve
https://apps.who.int/iris/rest/bitstreams/1322776/retrieve

WHO Considerations for Travel Measures

- Supplementary risk-mitigation measures may be considered (but only visual arrival screening, online prearrival forms, restricted movement of arrivals
  - 1) if the country of departure has a case incidence higher than the country of destination, and the country of destination does not have adequate capacities to cope with an increased burden (WHO provides a calculation template)
  - 2) in countries with low risk tolerance or those with no (active) cases, imported/sporadic cases, or a small number of cluster cases.

AND

- If a country has capacity to conduct testing broadly within its own population and will not divert resources testing may be considered for 1) and 2).

WHO Comments on Testing

- NAAT (but not antigen or antibody) testing may be considered for travelers, but WHO notes the reality of false negatives in those very recently infected and only a minor incremental benefit for serial testing.
- potential for significant falsification or fraud
- Engagement in risky behavior based on a false sense of security, stigma, and discrimination.
- WHO had earlier announced collaboration on a pilot project to develop a digitally enhanced International Certificate of Vaccination or Prophylaxis, which did not include a testing module.
  - Current status unclear

Travel Industry Advocating Testing Not Vaccination

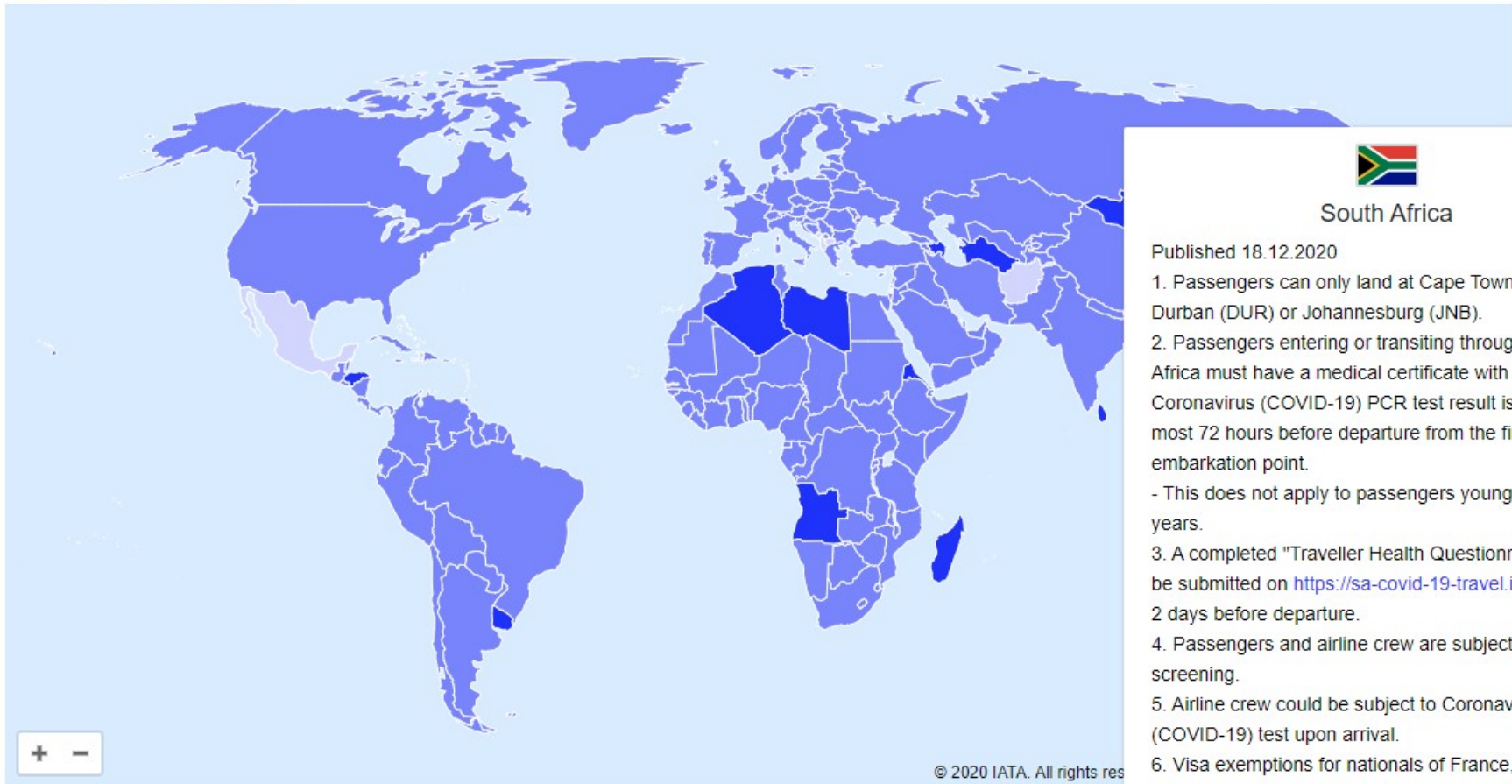
- Wide vaccine availability will take 2 years or more
- Current testing is robust but not 100% in preventing either in-flight transmission (passenger perspective) or in preventing importations (country perspective).
- Testing freezes only a single point in time
  - Even with high-sensitivity negative today says nothing about infectiousness the next day or the day after.
  - Multiple tests (PCR 48 hrs. before, rapid test in pre-board, rapid test on arrival) improve detection but cannot be implemented on a large scale.
- Exemption of flight crew from mandatory testing will become more obvious to public before long

TravelCentre

Home | Passport, Visa & Health | Country Information | COVID-19 News | Travellers FAQ | About Travel Centre |

COVID-19 Travel Regulations Map* (powered by Timatic)

14 January 2021 23:15:09 UTC



Totally Restrictive
Partially Restrictive
Not Restrictive
Latest updates currently under review

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South Africa

Published 18.12.2020

1. Passengers can only land at Cape Town (CPT), Durban (DUR) or Johannesburg (JNB).
2. Passengers entering or transiting through South Africa must have a medical certificate with a negative Coronavirus (COVID-19) PCR test result issued at most 72 hours before departure from the first embarkation point.
- This does not apply to passengers younger than 5 years.
3. A completed "Traveller Health Questionnaire" must be submitted on https://sa-covid-19-travel.info/ at most 2 days before departure.
4. Passengers and airline crew are subject to medical screening.
5. Airline crew could be subject to Coronavirus (COVID-19) test upon arrival.
6. Visa exemptions for nationals of France, Germany, Italy, Korea (Rep.), Portugal, Singapore, Spain, USA, for passengers with a Hong Kong (SAR China) passport and for passengers with a British normal passport with nationality "British Citizen", has been

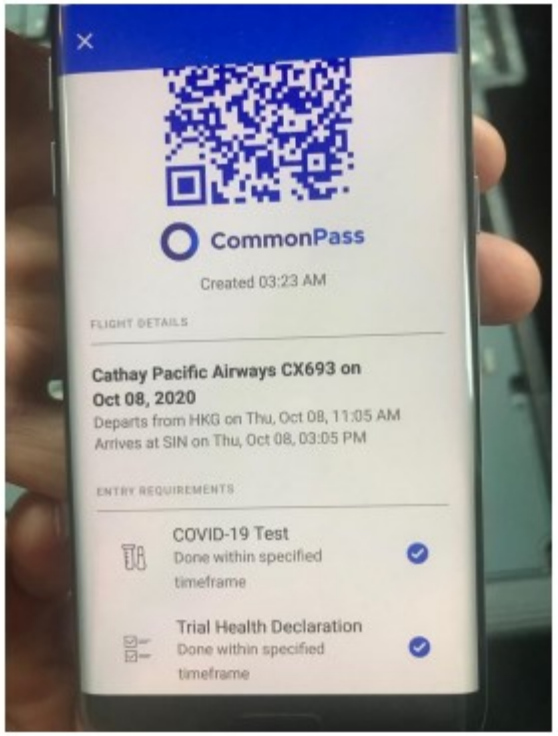
Pre-Entry PCR

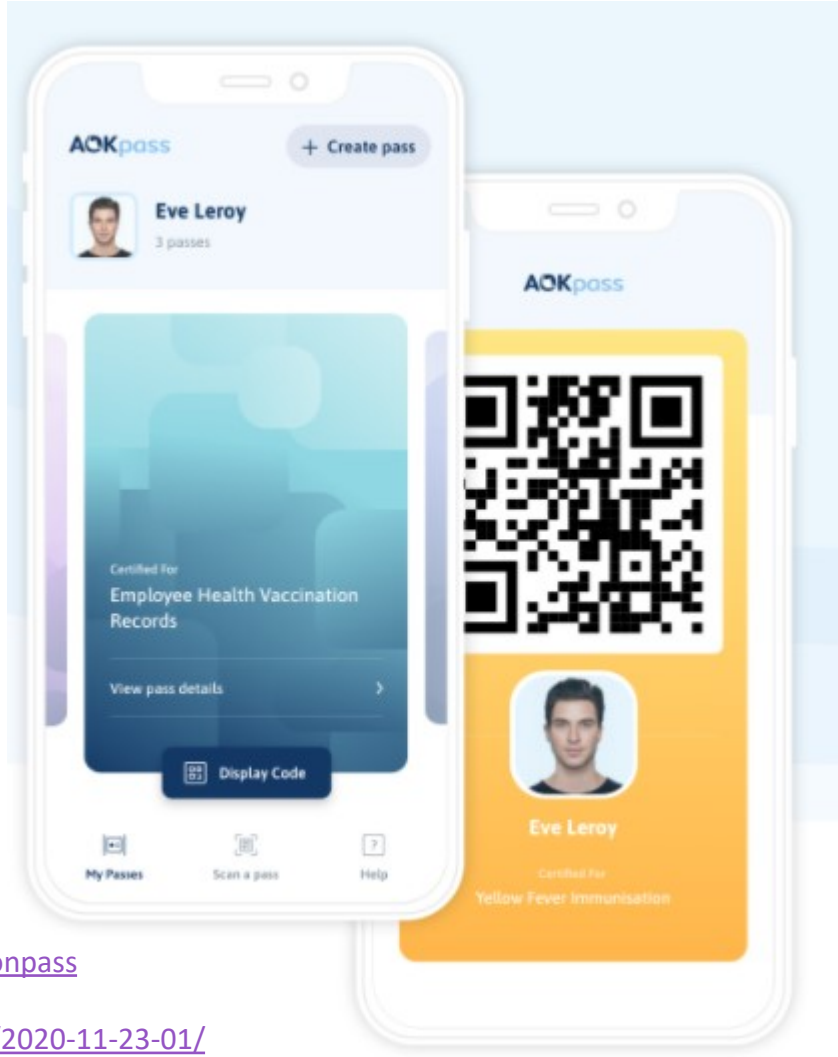
- Most countries still totally prohibit Entry by citizens of “red” countries
- >160 countries require all foreigners from “green” countries to be in possession of a negative COVID-19 PCR result from a test taken within a prescribed number of days prior to arriving
- >70 countries require a negative COVID-19 PCR test result (“test-out”) to be exempt from quarantine or other restrictions.
  - Although antigen testing may be more readily available, only PCR test results are accepted by the majority of these countries.
  - China most extreme: negative PCR, negative IgM, authorized testing labs, pre-flight verification by Chinese Embassy (electronic), Chinese QR code for boarding. Testing in each transit country

How the modules combine as an integrated service

Overview

4 Main Players-Health Passport Initiatives





- https://thecommonsproject.org/commonpass
- https://www.aokpass.com/
- https://www.iata.org/en/pressroom/pr/2020-11-23-01/
- https://mp.weixin.qq.com/s/qKU2aelENhE3uQSYMoGkdg

Table 1.1 Non-pharmaceutical Interventions that can be used to Control Transmission of the Novel Coronavirus SARS-CoV-2, where Layering NPIs can create Additive and/or Synergistic Benefits in Reducing the Risk of Exposure to COVID-19 for Passengers and Crewmembers during Air Travel

Phase of Gate-to-Gate Passenger Journey	Non-Pharmaceutical Interventions that can be Layered to Mitigate Risk of SARS-CoV-2 Transmission during Air Travel													
	Section 6.0 Testing & Screening			Section 7.0 Face Coverings			Section 8.0 Process Management		Section 9.0 Cleaning & Disinfection				Section 10.0 Physical Engineering	
NPI Layering Intervention	*Health Symptom Self-screening*	*Temperature Screening*	*Viral Testing*	*Mask*	*Respirator*	*Face Shield*	*Limiting Cabin Service*	*Boarding and Deplaning*	*Cleaning*	*Electrostatic Spray*	*UV Disinfection*	*Anti-microbial Coatings*	*Ventilation*	*Enhanced Ventilation for Boarding/Deplaning*
Preparation of Airplane	–	–	–	++	–	–	–	–	++	++	*	*	–	–
Pre-Boarding	++	++	*	++	–	–	++	++	++	–	–	–	++	*
On Board at Cruise	–	▲	–	++	▲	▲	++	–	++	–	–	*	++	–
Deplaning	–	*	–	++	–	–	–	++	++	–	–	–	++	*

NPIs Non-pharmaceutical Interventions

– Not applicable
++ Recommended
* Desirable/optional
▲ May be appropriate under certain circumstances

Route of Transmission:

- Direct contact with infectious droplets
- Inhalation of infectious aerosols
- Indirect contact with infectious agents contaminating inanimate surfaces (fomites)

Summary: "Gate to Gate" Solutions

"Curb to Curb" Present Other Issues

HARVARD T.H. CHAN SCHOOL OF PUBLIC HEALTH | NPLI NATIONAL PREPAREDNESS LEADERSHIP INITIATIVE | HARVARD Kennedy School Center for Public LEADERSHIP

The National Preparedness Leadership Initiative is a joint program of the Harvard T.H. Chan School of Public Health and the Harvard Kennedy School of Government, Center for Public Leadership

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

Faculty and Scientists at the Harvard T.H. Chan School of Public Health

Out of that interest to reopen the sector safely, discussions began between Airlines for America (A4A) and faculty at the National Preparedness Leadership Initiative (NPLI), a joint program of the Harvard T.H, Chan School of Public Health and the Harvard Kennedy School of Government.

Those conversations led to development of the Aviation Public Health Initiative (APHI). As lead sponsoring organization, A4A engaged their member organizations, along with a group of manufacturers and airport operators. These companies generously provided financial support, shared data and information, facilitated conversations with airline COVID-19 working groups, and opened opportunities to speak with the airline crewmembers. That breadth of conversation

Questions and Comments-put in Chat Box for Session End

-if desired happy to address nuances of testing requirements by various countries

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