In-flight COVID-19 transmission risk and feasible mitigation strategies

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Brief Outline

- In-flight epidemiology of COVID-19: data so far
- Feasible mitigation strategies: already employed and potential changes

Estimated air travel

- 2019
  - 4.5 billion passenger departures
  - 39 million scheduled flights
  - 8.7 trillion Revenue Passenger Kilometers (RPKs)

- 2020
  - 2.2 billion passenger departures(– 51.6%)
  - 23 million scheduled flights (– 40.6%)
  - 3.9 trillion RPKs (– 54.7%)

Source: https://www.iata.org/en/publications/economics/

In-flight transmission

- Greece (Pavli et al., 2020, *Travel Medicine & Infectious Disease*)
  - February-March, contact tracing of 18 international flights
  - 21 index cases (6 symptomatic in-flight)
  - 891 contact cases
  - **4 passengers seated within two seats** to the index cases and one crew member were diagnosed with SARS-CoV-2 infection
  - All on same flight with 2 index cases who had symptoms during the flight

In-flight transmission

- London to Vietnam (Khahn et al., 2020, *Emerging Infectious Diseases*)
  - Vietnam Airlines flight 54; March 2020: 16 crew and 201 passengers
  - Probable 1 index case was symptomatic (sore throat & cough), SARS-CoV-2 positive on March 5.
  - **15 PCR-confirmed COVID-19 cases (14 passengers, 1 crew members)**
  - Among passengers seated within **2 meters from case** 1, 11 (92%) were SARS-CoV-2–positive compared with 1 (13%) located >2 seats away (risk ratio 7.3, 95% CI 1.2–46.2)

In-flight transmission

- Boston to Hong Kong (Choi et al., 2020, *Emerging Infectious Diseases*)
  - Departed Boston March 9, arrived in Hong Kong on March 10, ≈15 hours and 294 passengers
  - Cluster of infections: 2 passengers and 2 cabin crew: all asymptomatic in-flight
    - 1 flight attendant served two passengers in-flight
    - Viral genomes from all were 100% identical
  - Based on genomic sequencing, one or both passengers contracted SARS-CoV-2 in North America and **transmitted to crew** during the flight
    - **No other passengers or crew were reported positiv**

In-flight transmission

- Milan to South Korea (Bae et al., 2020, *Emerging Infectious Diseases*)
  - 310 passengers, 11 hour *evacuation flight
  - N95 respirators were provided, and passengers were kept 2 m apart for physical/social distancing before boarding.
  - **One passenger** became infected after the flight

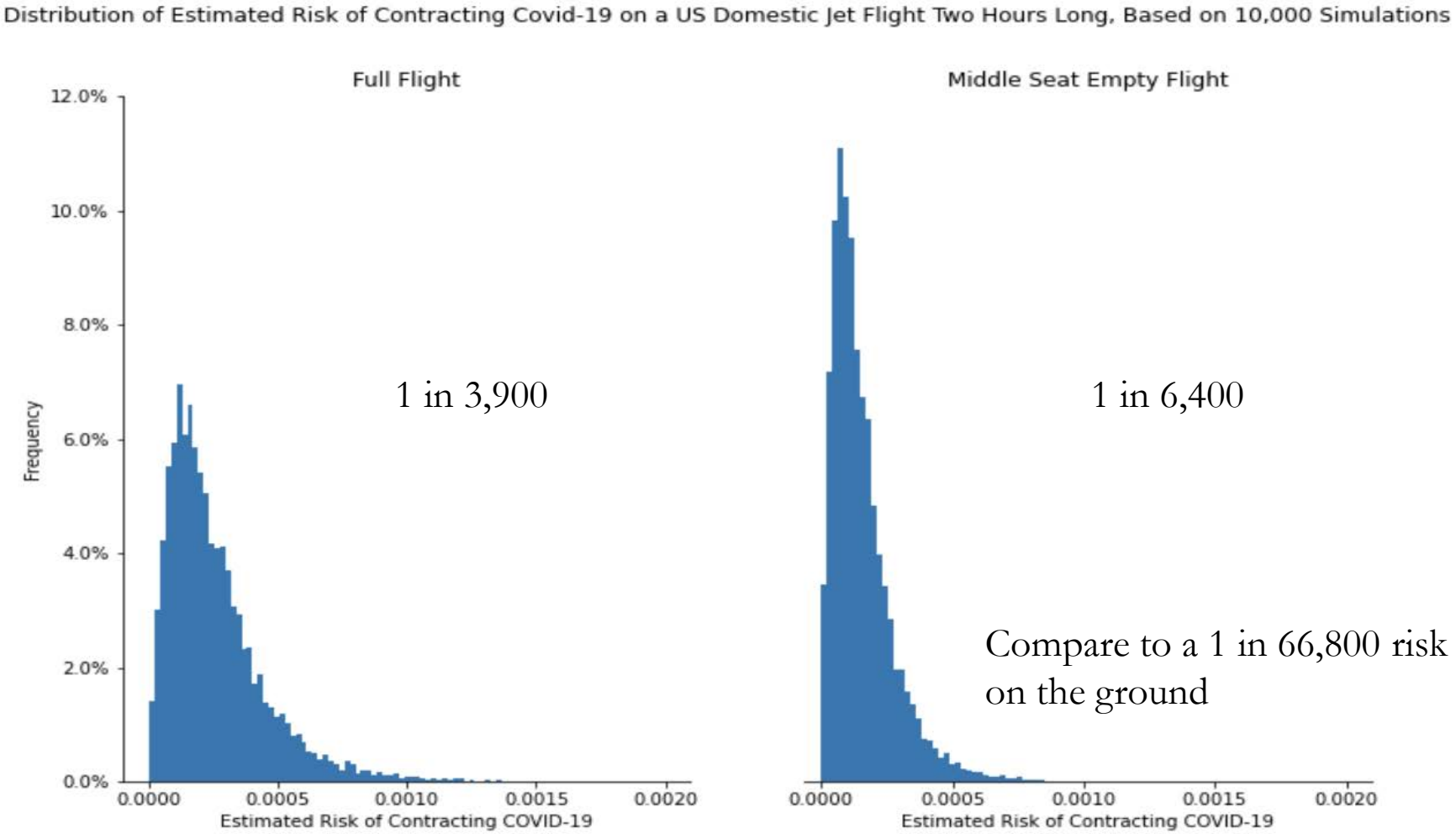
In-flight transmission

- Freedman DO & Wilder-Smith A. 2020, *Journal of Travel Medicine*.
  - 3 flights with mass transmission events (>1 secondary case)
    - Masking not mandated on any of these
  - 1 flight with 25 PCR+ passengers, but only 2 transmissions (one next to 5 index cases)
    - Rigid masking
  - 5 flights with no secondary cases despite 58 passengers who were PCR+ on a total of 5 flights of 8 hours each with ~1500–2000 passengers
    - Rigid masking

In-flight transmission

- Dubai to Auckland (Swadi et al. 2021. *Emerging Infectious Diseases*)
- September 2020, 18-hour, flight, 86 passengers
- 2 index cases **all seated within 2 rows**
  - 4 in-flight transmissions
  - 1 in managed isolation/quarantine site
- Masks and gloves worn

Overall risk for in-flight transmission



1 in 3,900

1 in 6,400

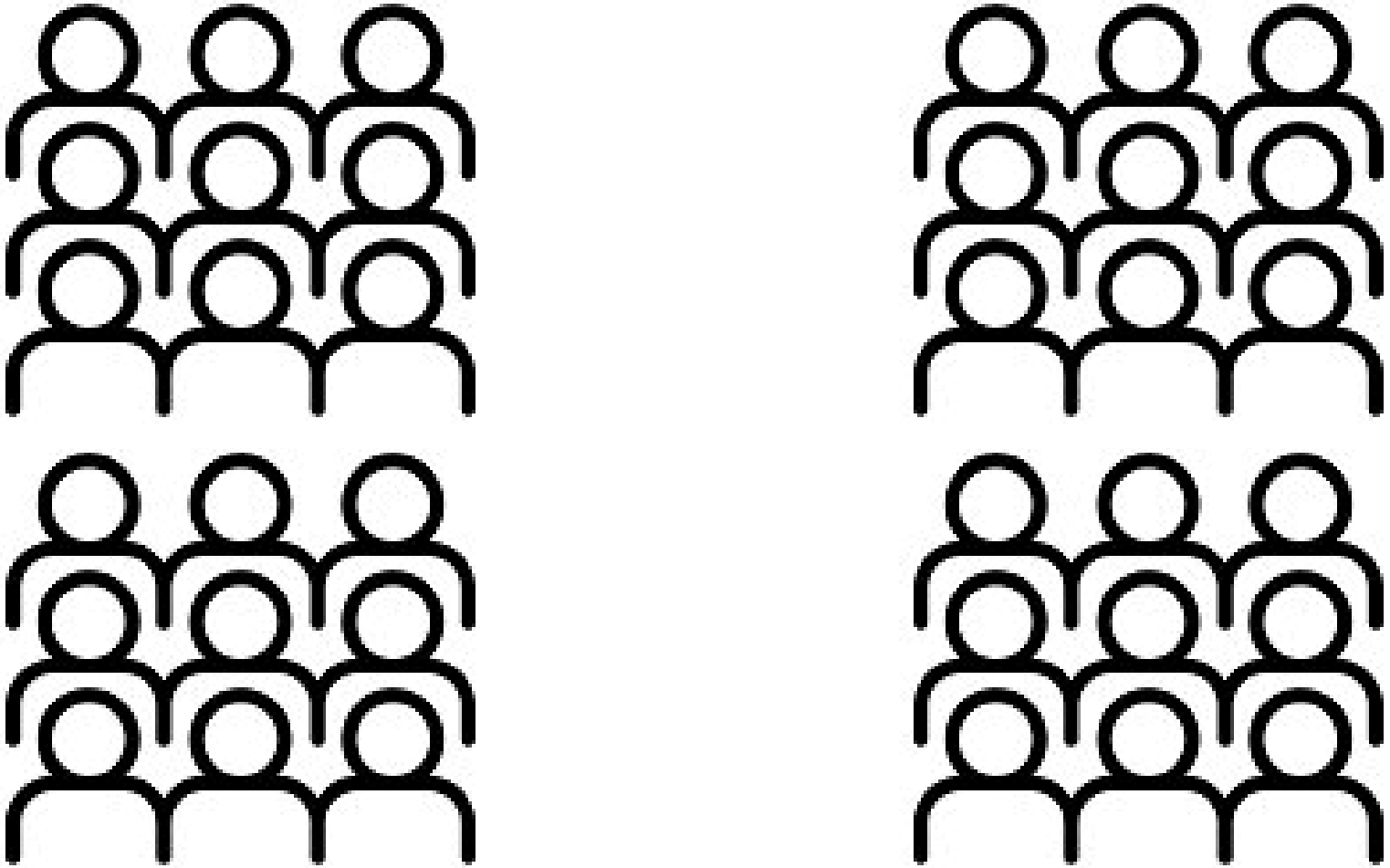
Compare to a 1 in 66,800 risk of that same traveler on the ground

Barnett A & Fleming K. (Preprint)

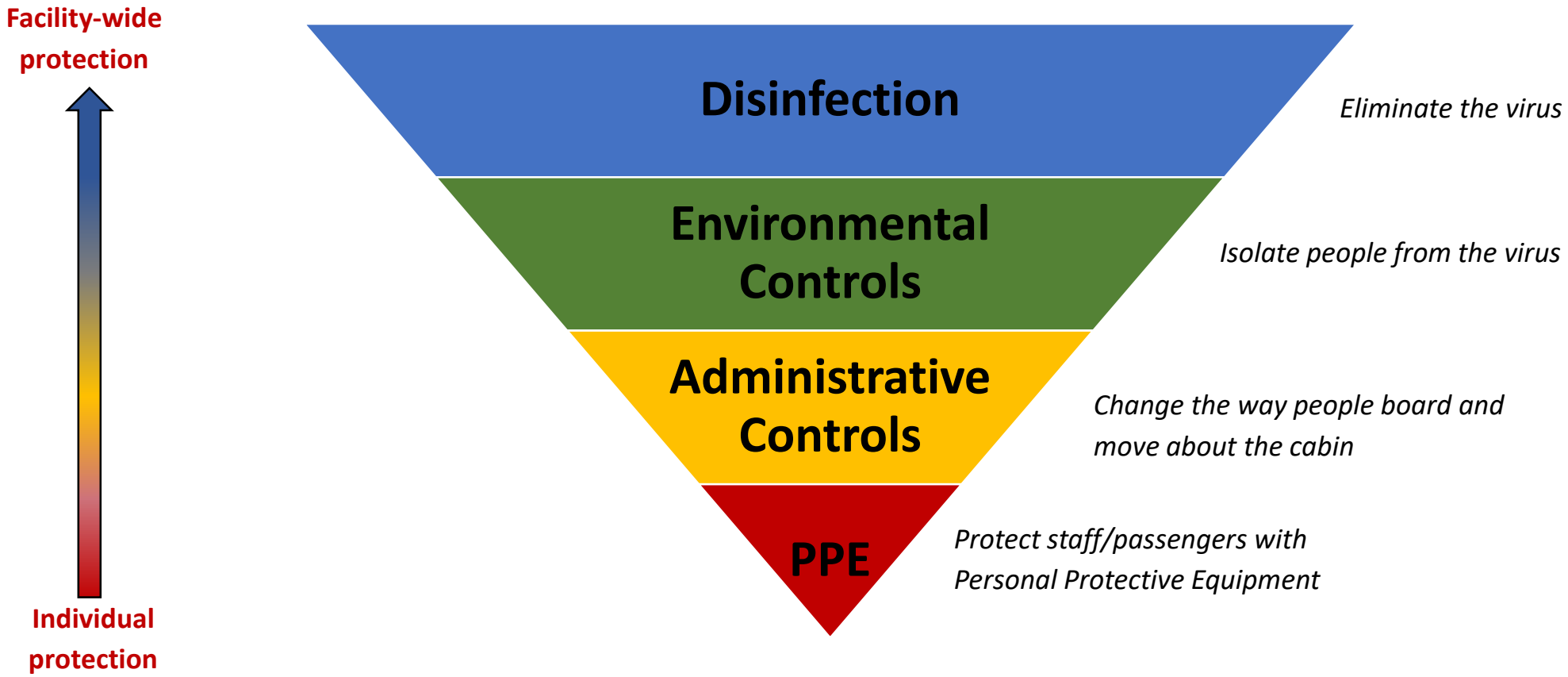
In-flight risk

- Risk of flight is significantly higher than on the ground
- Risk attenuated by distance apart and masks
- Evidence-based mitigation efforts need to be sustained for foreseeable future

Airplanes as temporary congregate settings

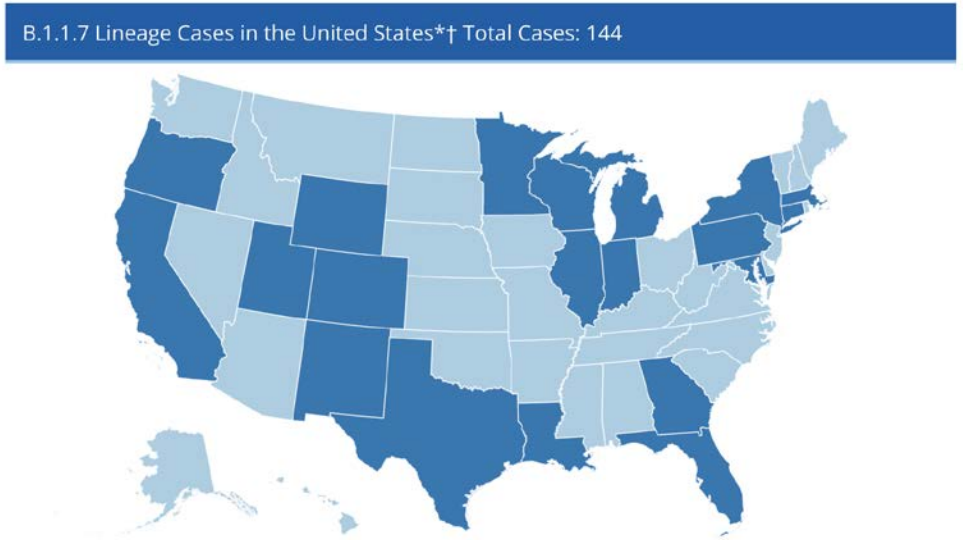


Mitigation efforts using the "hierarchy of controls" framework



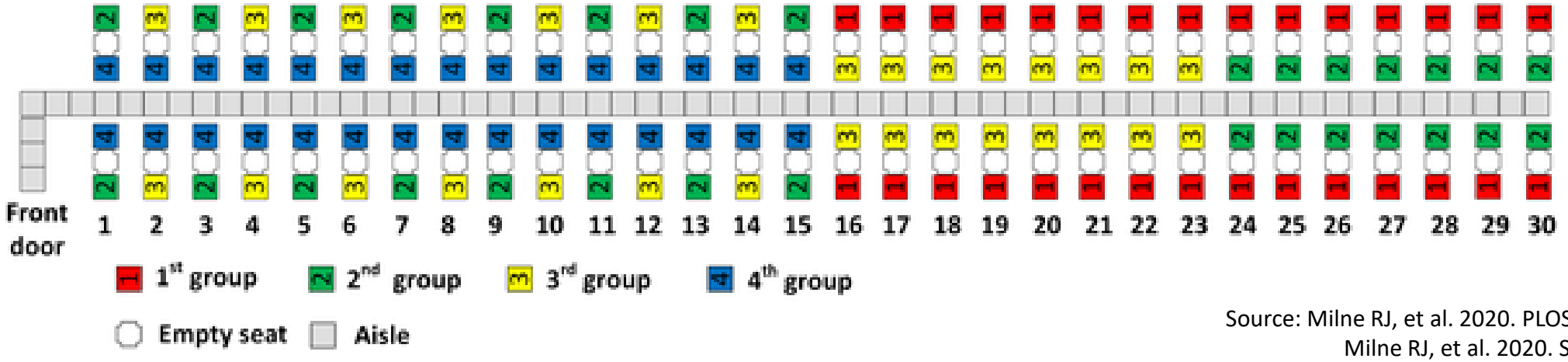
PPE: providing individual protection throughout the flight

- Mandated Masks:
  - Flight crew: surgical masks at all times; optional N95
  - Cleaning crew: surgical masks
  - Passengers: surgical masks except when eating/drinking (even in lavatory)
  - Resuscitation kits: N95 masks
- Face shields/goggles for flight crew



Administrative controls: change the way people board and move about the cabin

- Decrease boarding time (and maintain distance during boarding)
  - **4 group Reverse Pyramid (RP) Spread** airplane boarding (below)
    - Variations by number of groups, luggage, etc
  - **Back-to-front by row** boarding



Source: Milne RJ, et al. 2020. PLOS ONE
Milne RJ, et al. 2020. Saf Sci

Administrative controls continued

- Unmasked time
  - Limit eating/drinking unmasked to under 15 minutes
  - Stagger eating/drinking times on long haul flights by row
- Minimize crew movement
  - Limit food/beverage service and trash collection

Environmental Controls: isolate people from the virus

- Antigen testing crew prior to flight
  - Self-testing with non-invasive saliva tests
    - 91% sensitivity
  - Abbott BinaxNOW is 92.6% effective at identifying positive cases when people are infectious

- Antigen testing passengers without documented vaccination
  - Equity perspective: not everyone has access to vaccine
- Seating
  - Middle seat open (recommended against by IATA)
    - Previous studies demonstrate reduced probability of infection with middle seat open seating

Environmental Controls continued

- Symptomatic person
  - Rapid medical assessment
    - Extreme respiratory distress increases likelihood of death and transmission
    - Mask patient while receiving oxygen
  - Isolation seat
    - Reserve seat for newly symptomatic patient
    - Move others, if possible
  - Enhanced masking
    - Persons within 2 rows given N95 masks
    - Patient and crew given N95
  - In-flight antigen testing (confirm infectivity/positivity)
    - Administer to patient and any traveling partners

Disinfection: eliminate the virus

- Airflow
  - High airflow: replace cabin air every 2-4 minutes
- Air filtration
  - HEPA filters (standard on aircraft) remove over 99.9% of particles with aero-diameter >0.3 μm.
  - As efficient at 0.01 μm (SARS-CoV-2 = 0.125 μm)
  - High airflow and use of HEPA filters onboard planes make it unlikely to catch the virus from someone who is not in the immediate vicinity
- Disinfection
  - High frequency touchpoints should be disinfected (60% alcohol) between flights and inflight
  - Passengers advised to wipe down tray tables, headrests and armrests before use

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