SOME THOUGHTS ON PREVENTING INFECTIOUS DISEASE TRANSMISSION DURING AIR TRAVEL

NAS WORKSHOP

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ABOUT ME

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DOCUMENTED IN-FLIGHT TRANSMISSION OF INFECTIOUS DISEASES

COVID-19	Meningococcal infection
SARS	Norovirus
Influenza (including H1N1p)	Shigellosis
TB	Cholera
Measles	

COVID-19, SARS, and H1N1p transmission on airplanes indicate that air travel can serve as a conduit for the rapid spread of newly emerging infections and pandemics.

FLYHEALTHY PEER-REVIEWED PUBLICATIONS

PNAS

Behaviors, movements, and transmission of droplet-mediated respiratory diseases during transcontinental airline flights

2018

Vicki Stover Hertzberg[a,1,2], Howard Weiss[b,1], Lisa Elon[c], Wenpei Si[d], Sharon L. Norris[e], and The FlyHealthy Research Team[3]

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2016

ORIGINAL RESEARCH

On the 2-Row Rule for Infectious Disease Transmission on Aircraft

Vicki Stover Hertzberg, PhD, Howard Weiss, PhD
Atlanta, Georgia

Microbial Ecology (2019) 77:87–95
https://doi.org/10.1007/s00248-018-1191-3

2019

ENVIRONMENTAL MICROBIOLOGY

The Airplane Cabin Microbiome

Howard Weiss[1] · Vicki Stover Hertzberg[2] · Chris Dupont[3] · Josh L. Espinoza[3] · Shawn Levy[4] · Karen Nelson[5] · Sharon Norris[6] · The FlyHealthy Research Team

MODE OF TRANSMISSION OF CORONAVIRUSES, INFLUENZA, ETC.

Current understanding: **in built environments with high air exchange rate (e.g., airplane cabins during flight, hospitals), most direct transmission occurs within 1-2 meters of infectious person.**

<u>However</u>-

We located 6 reports of inflight transmission (SARS x 2, Influenza x 4) with seat maps showing transmission, and we found that 30 cases occurred within 2 rows (~2 meters) of infectious passenger and 26 occurred beyond 2 rows.

Hertzberg, Vicki Stover, and Howard Weiss. "On the 2-row rule for infectious disease transmission on aircraft." *Annals of global health* 82.5 (2016): 819-823.

SARS TRANSMISSION ON CA 221 HKG-PEK

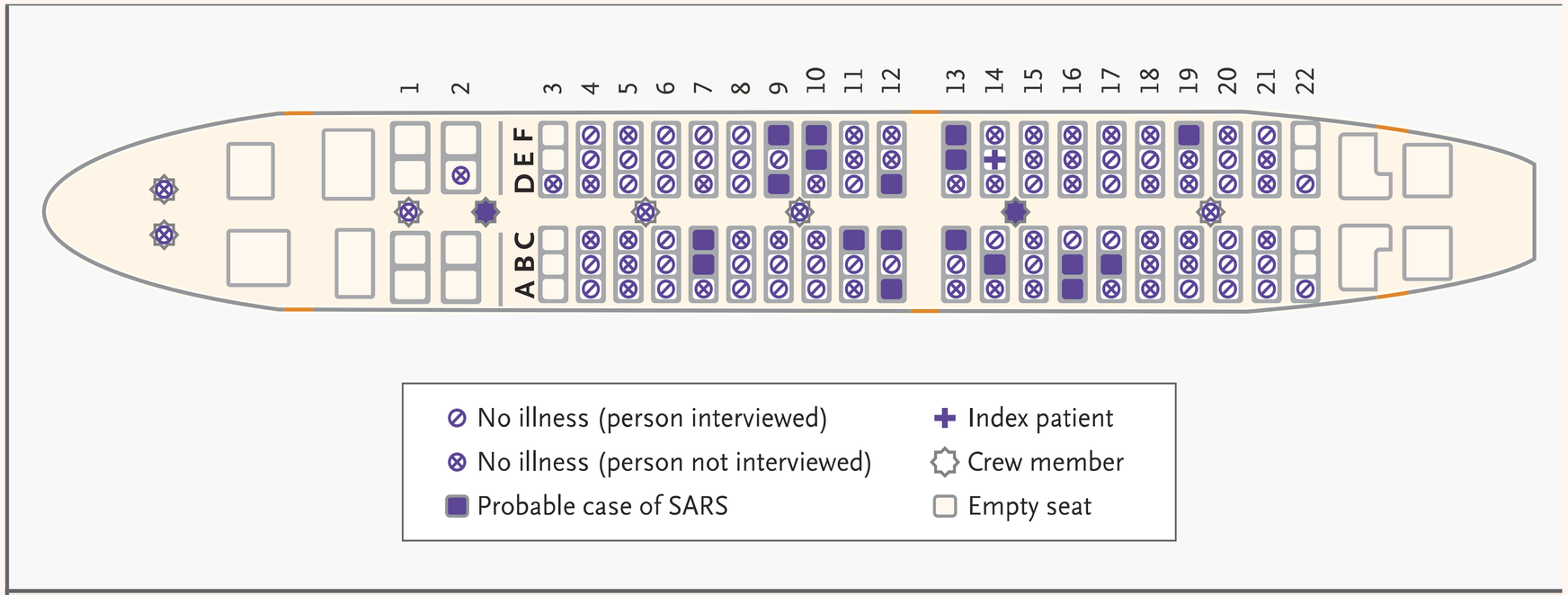

Figure 2. **Schematic Diagram of the Boeing 737-300 Aircraft on Flight 2 from Hong Kong to Beijing.**

HOW TO PREVENT TRANSMISSION OF RESPIRATORY INFECTIOUS DISEASES DURING AIR TRAVEL?

- Universal masking (N95, KN95) by everyone during entire flight may go a long way toward prevention
- But universal masking is highly burdensome and impractical
- More effective strategy: **keep infectious passengers off airplanes, and even better, prevent them from entering far into terminal**
- How???

HOW TO KEEP INFECTIOUS PASSENGERS OFF AIRPLANES?

- **Ideal:** Biosensor at security screening would sample exhaled air from individuals and instantly screen for respiratory diseases of concern.
- **Major obstacle:** A small sample of exhaled air from infectious individual contains only tiny amounts (femtograms) of nucleic acid.
- The nucleic acid needs to be amplified and traditional PCR thermocyclers take 45-60 minutes to complete a reaction. Also RT (RNA ->cDNA) step traditionally takes about 60 minutes to complete.
- Newer DNA amplification methods can be done at constant temperature and much more quickly, and cleverly designed enzymes can greatly speed up the RT step.
- **How close are we to rapid detection / identification of infectious passengers?**

RAPID DETECTION OF COVID

1. Isothermal nucleic acid amplification via **Loop Mediated Isothermal AMPlification (LAMP)**

Notomi, T., Okayama, H., Masubuchi, H., Yonekawa, T., Watanabe, K., Amino, N., & Hase, T. (2000). Loop-mediated isothermal amplification of DNA. *Nucleic acids research*, *28*(12), e63-e63.

Implemented in, for example, Abbott ID NOW system, which received FDA EUA, **13 minutes** for COVID-19 (and Influenza) identification from throat or nasal or nasopharyngeal swab, sensitivity 76%, 84%, 93%, etc. (different results from different studies, sensitivity seems to struggle with low viral load) and 99% specificity.

In principle, if samples are taken at security screening, then we can prevent infectious passengers from boarding aircraft

RAPID DETECTION OF COVID

2. Isothermal nucleic acid amplification via **Exponential Amplification Reaction (EXPAR)**

Proof of concept

“By combining EXPAR with a novel reverse transcriptase-free (RTF) step, this new assay, RTF-EXPAR, can accurately identify viral RNA derived from COVID-19 patient samples in less than 5 minutes ”

Carter, J. G., Iturbe, L. O., Duprey, J. L. H., Carter, I. R., Southern, C. D., Rana, M., ... & Dafforn, T. R. (2021). Sub-5-minute Detection of SARS-CoV-2 RNA using a Reverse Transcriptase-Free Exponential Amplification Reaction, RTF-EXPAR. ***medRxiv***, 2020-12.

Caution: preprint

RAPID DETECTION OF COVID

3. **Electrochemical Impedance Spectroscopy**

Technique used since 2008 to detect influenza virus

For COVID

Torres, M. D., de Araujo, W. R., de Lima, L. F., Ferreira, A. L., & de la Fuente-Nunez, C. (2021). Low-cost Biosensor for Rapid Detection of SARS-CoV-2 at the Point-of-Care. *Matter*.

RAPID 1.0 (real-time accurate portable impedimetric detection prototype 1.0) transforms biochemical information from a specific molecular binding event between the spike protein and ACE2 into an electrical signal that can easily be measured.

Authors claim **4 minute** detection, >85% sensitivity and >85% specificity for nasopharyngeal/oropharyngeal swabs and saliva samples, using low-cost ($5) materials.

CONCLUDING REMARKS

- Other very rapid detection technologies are currently under investigation.
- In a few years, it will likely be practical to inexpensively, and with high accuracy, screen passengers and crew for respiratory infectious diseases of concern and obtain results in less than **1 minute**.
- Respiratory diseases of concern in airplane cabins include newly emerging strains of Influenza and Coronaviruses, and perhaps TB (on international flights), Measles, bioterror agents
- Generic Coronavirus and Influenza tests (using highly conserved genome regions) may immediately detect newly emerging strains (but can’t distinguish between old and new strains)
- Preventing infectious passengers from leaving security area obviates need for changes to aircraft and terminal ventilation systems, aircraft seating, aircraft boarding, health passports, contact tracing, dealing with uncooperative passengers, public concern about flying during outbreak, disease transmission route, etc.

Thank you

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