Testimony of Dr. Vicki Hertzberg

House Committee of Science, Space & Technology

Subcommittee on Space & Aeronautics

“R&D to Support Healthy Air Travel in the COVID-19 Era and Beyond”

June 23, 2020

Ladies and Gentlemen of the Committee,

Good morning.

(1) Disclaimer. Contents of my testimony represent my opinion and are not the official opinion of Emory University.

(2) Biographical Information. My name is Vicki Stover Hertzberg. I hold a B.S. in Mathematics & Statistics from Miami University in Oxford, Ohio, class of 1976, and a Ph.D. in Biomathematics – Health Statistics track from the University of Washington in Seattle, Washington, granted in 1980. I was on the faculty of the University of Cincinnati, Division of Epidemiology and Biostatistics, 1980 – 1995. I have been on the faculty of Emory University since 1995. I served as chair of the Department of Biostatistics 1995-2001 in the Rollins School of Public Health. In 2015 I moved to the Nell Hodgson Woodruff School of Nursing where I am Professor and direct the Center for Data Science. I have published over 130 articles in the peer-reviewed literature. I am a Fellow of the American Statistical Association, and I have also held that association's P.Stat. accreditation since 2010 when it was first offered.

(3) Next, I review how I developed particular expertise that qualifies me to testify before you today. As a result of the SARS epidemic in 2002-2004, many organizations became concerned about how a novel infectious agent might spread in their environments. There were two papers published in the medical literature documenting such spread for SARS. One publication described how a SARS patient presented at the emergency department (ED) of a community hospital in Toronto during the course of the epidemic, and 126 subsequent hospital-acquired SARS infections among patients and staff were traced to direct or indirect exposure to this patient, of whom several died. This particular case gave rise to my collaboration with Dr. Douglas Lowery-North, who was at the time the vice-chair for operations in the Emory University Department of Emergency Medicine, beginning in 2005. In 2007 we were funded to do a pilot study in which we determined how a novel infectious agent transmitted by large respiratory droplets would spread among patients and staff in the ED. We studied patients and staff in the ED at Emory University Hospital Midtown in 81 12-hour shifts over the course of a year, July 1 2009 – June 30 2010. We used radiofrequency identification (RFID) to determine how frequently and for how long patients and staff came into “contact” with one another, where we defined contact as 1 meter of proximity, or approximately 3 feet. CDC and WHO guidance

at the time averred 1 meter as the distance over which large respiratory droplet transmission of diseases like SARS or influenza could occur. We collected these data, which became the source of 4 subsequent research publications. In one of these papers, we used the data to simulate how an infection might spread by randomly making one patient or one staff “infectious” with a novel agent and determining how many other staff and patients might become infected as a result of contact with this “infectious” individual. Over 10,000 such simulations, we found that cross-infection risk between ED health care workers was much higher than between health care workers and patients or between patients. On average, 11 patients who were infected in the ED would be admitted to the hospital over the course of an 8-week outbreak of such an infection, leading to further cross-infection risk once in the hospital.

Another publication documented SARS transmission on a 3 hours flight from Hong Kong to Beijing. There were 120 people on this flight, including one infectious passenger. Afterwards 16 people developed laboratory confirmed SARS, 2 were diagnosed with probable SARS, and 4 were reported to have SARS but could not be interviewed. Thus, airplane cabins are another environment of concern.

My colleague at Georgia Institute of Technology, Professor Howard (Howie) Weiss, an applied mathematician who models infectious disease outbreaks, was aware of our work in the ED. In 2011 he was approached by Dr. Sharon Norris, who was at that time the chief physician of The Boeing Company. Dr. Norris was interested in studying how a novel infectious agent transmitted by large respiratory droplets might spread among passengers and flight attendants ("crew") on an airplane. Professor Weiss and I prepared a proposal to The Boeing Company to do so, and this proposal was subsequently funded. Our first goal was to quantify behavior and movements by passengers and crew so that we could determine which pairs of individuals were coming into sufficiently close contact as to enable infection transmission. Our second goal was to understand what, if any, infectious agents were present on airplanes.

With additional assistance of experts from Delta Airlines, CDC, TSA, and NIOSH, we trained a team of graduate students in observation and recording. This team, along with Professor Weiss and three post-doctoral scholars made 5 round trips, that is, 10 flights, between Atlanta and various West Coast cities between November 2012 and May 2013. We could not use RFID to determine contacts, so we resorted to using observation. Over the course of each flight a team of 10 graduate students observed and recorded the behaviors and movements of passengers and flight attendants in the economy cabin from the time that the plane had reached 10,000 feet altitude on ascent until the time that the plane had reached 10,000 feet altitude on descent, on average, about 4 hours per flight. The post-doctoral scholars took environmental samples of air and touch surfaces before and after each flight, and also took environmental samples of air during the flight. All flights were on Boeing aircraft of a single aisle 3 + 3 seat configuration, with one lavatory near the front and two in the rear. All flights were at or near full capacity, with 1-2 empty seats at most available on each flight, if any.

From the data collected by the graduate students we were able to reconstruct movements by passengers and crew on these 10 flights. In order to simulate how a novel infectious agent might spread on an airplane, we created 1000 “fantasy flights” in which we created a seat map of a single aisle, 3 + 3 seat economy cabin, and randomly selected passengers and crew to populate each fantasy flight from our dataset, with their empirical behaviors and movements becoming their simulated behaviors and movements on the fantasy flights. We determined all contacts over which a large respiratory droplet novel infectious agent could spread on all fantasy flights. Subsequently we made either a passenger or a crew member infectious, and simulated infection transmission 10,000 times, repeating for all 1000 simulated flights. For these simulations we used as the rate of infection an estimate we obtained from data given in a paper by Moser et al. that appeared in the American Journal of Epidemiology in 1979. This paper described transmission of influenza on an airplane that was grounded on a tarmac in Alaska for 3 hours with no air circulation. From that episode of confinement, 72 percent of the 54 passengers aboard became ill with symptoms of an influenza-like illness within 72 hours. We calculated the transmission rate from these data, then quadrupled ("super-sized") it for the transmission rate in our simulation. From these simulations we produced heat maps showing the median probability of infection over 1000 simulated flights from a given passenger or crew source.

Environmental samples were shipped to and processed by the Genomic Services Lab at HudsonAlpha Institute for Biotechnology (Huntsville, AL). Each of the 229 environmental samples was split into two, from which DNA and RNA were isolated. One aliquot from each air sample was tested using qPCR against a panel of 18 commonly circulating respiratory viruses, including the influenza A H1N1 2009 pandemic strain, as well as three coronavirus strains.

HudsonAlpha Institute for Biotechnology also performed DNA sequencing of the V4 hypervariable region of the 16S rRNA gene for each sample. Following bioinformatics processing of the sequences by world-class experts at the J. Craig Venter Institute we were able to determine the bacteria and archaeae present in the airplane cabin environment, effectively characterizing the airplane cabin microbiome.

The study resulted in two major publications. The first manuscript gave the characterization of behaviors and movements of passengers and crew, described results of our simulation studies, and recounted outcomes of the qPCR respiratory virus panel testing. This manuscript was published in *Proceedings of the National Academies of Sciences of the United States of America* (PMID: 29555754), first appearing on March 19, 2018. The second manuscript gave the results of the 16S rRNA gene sequencing. This manuscript was published the journal *Microbial Ecology* (PMID: 29876609), first appearing on June 6, 2018.

There are three major findings from our study.

1. Based on our simulations, 1-2 passengers or crew member will become infected as a result of contact with an infectious individual on a cross-country flight.
2. Our respiratory virus qPCR panels were all negative for all air samples and all viruses.
3. The microbial communities present on airplanes are highly variable from flight to flight, with the vast majority of airplane-associated microbes being human commensals or otherwise non-pathogenic.

Our findings set a baseline for non-crisis-level airplane cabin conditions.

Following our study, prospects for further funding from The Boeing Company evaporated. Although there was some discussion with Dr. Norris about other studies, including studies of long-haul flights to China or Japan, there was no funding forthcoming. Professor Weiss and I thought that the prospects of funding from the National Institutes of Health or the National Science Foundation were low and did not think that the significant time investment on our part to develop a proposal would result in funding. Dr.

Norris attempted to build a funding consortium with the CDC, FAA, ASHRAE, US Department of Health and Human Services, IATA, etc., but was unable to do so. Dr. Norris retired from The Boeing Company in February of this year. In September 2019, Professor Weiss accepted a new faculty position at Pennsylvania State University.

(4) Implications of Our Findings for Air Travel in This Pandemic. Our results demonstrate that if the SARS-CoV-2 virus is as contagious as the influenza virus with the transmission rate that we “super-sized” in our simulation, one can expect 1-2 passengers or crew to become infected on a full flight of 4 hours duration. The implication of this finding is significant. **Unless airlines are willing to mandate that passengers and crew show up at least 4 hours in advance of a flight for nasopharyngeal swabbing of all passengers and crew followed by PCR testing for presence of the virus and prevent anybody with a positive test from boarding, and if flights continue to be at or near capacity, there is no way to <u>guarantee</u> that SARS-CoV-2 virus will not be transmitted during flight.**

(5) Knowledge Gaps. What are the known unknowns regarding safety of air travel in light of transmission of a novel infectious agent?

1. I am not aware yet of good data that would allow us to determine an infection rate to use in simulations.
2. The inverse problem needs to be solved – that is, given a passenger that subsequently develops disease, where was the infectious person likely seated.
3. Our results are only applicable to large respiratory droplet transmission. We do not know about transmission from
    a. aerosol (smaller droplets) generation; or
    b. fomites, that is physical objects that facilitate infection transfer between people.
4. Our results are only applicable to time in flight, between 10,000 feet on ascent to 10,000 feet on descent. There are other places along the way to traveling by air in which infection can be transmitted, and we know little about those places. These include:
    a. Transportation to and from the airport
    b. Areas traversed from check-in to the gate
    c. Passenger mingling in the gate house
    d. Baggage claim

I will add here that a group of investigators led by Ashok Srinivasan at University of West Florida is examining how transmission can occur in the boarding and deplaning processes.

5. We do not know anything about passenger behaviors and movements on double aisle planes, long-haul flights, or flights outside the U.S.

This concludes my remarks. Thank you for the opportunity to testify.