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PROFESSOR: So besides our physical expectation that a virus such as SARS-CoV-2, coronavirus, could be transmitted through respiratory droplets, especially aerosol droplets through the airborne route of transmission, there is substantial evidence-- both epidemiological evidence and some physical evidence-- to support this hypothesis.

So first, let's go through some of the epidemiological evidence.

This is a very small fraction of what is available to date.

So one of the first incidents that gave a sense there might be airborne transmission was a religious event that took place at the Tiantong Temple in Ningbo China, where there were hundreds of people in attendance.

But in particular, there were two buses that brought worshippers in one-hour bus rides to this location.

And on one of the buses was what was known to be the first infected person with COVID-19, entering this region after having had contact with others from Wuhan China, the initial source of the outbreak.

And on the bus where the infected person was, 23 out of 68 passengers became infected during that ride.

And despite the fact that there was also contact in the larger temple building with many other people, very few there were infected.

And on the second bus, where they kept the same seating, there were no infections.

So that gave a sense that on public transportation, there could be substantial superspreading going on.

So shortly afterwards, there were a number of incidents, including a case in a restaurant in Guangzhou, China, where an infected person was sitting at a table having dinner with a party there.

And there was a documented transmission to a far corner of the room with a person who had not been within a short distance such as six feet of the infected person, had not touched anything that could have led to contact transmission.

And it was concluded that it could only be explained by airborne transmission.

Then there was a well-known case involving a cruise ship-- one of several such cases-- of the Diamond Princess cruise ship, where a few infections were detected.

And on February 3, 2020, the ship was quarantined in the harbor of Yokohama, Japan.

And during that quarantine, out of 3,011 passengers and crew on the ship, there were a total, at the end of 12 days, of 354 infected persons, starting from an initial estimate of-- well, several known cases.

And by our own analysis, we will be estimating there were perhaps around 20 initial cases, so a dramatic increase in the number of infected persons in 12 days, despite the fact that the passengers were mostly confined to their cabins with very little movement between.

And also, later analysis showed that there was very little statistical correlation between contact with an infected person even being in the same room and getting a transmission.

In other words, transmission was happening between people in different rooms, even on different floors, presumably through the air handling system.

And among many other events that followed, another famous case was one of the initial sources of spreading in South Korea was the Shincheonji Church, which held services over the period of February 16 to 25.

And a significant fraction of thousands of churchgoers were infected, that led to the initial outbreak in Korea, again, coming from contact of a large number of people sharing an indoor space, where it's not possible for each of those people to have been touching each other or within 3 or 6 feet.

But rather, the only plausible explanation is transmission through the air.

Another such example in Korea had to do with a call center, where it was hundreds of people working in a building with many floors.

And there was an infected person in one large room of one of the floors.

And a significant fraction of the co-workers were infected in that call center and yet a relatively small number in other parts of the same floor or on other floors, again pointing to airborne transmission after subsequent analysis.

And then one of the first cases in the United States famously occurred in the Skagit Valley Chorale, which was holding a choir practice in Mount Vernon, Washington, USA.

We will be analyzing this case in more detail.

But it very dramatically showed the evidence for airborne transmission, because in a 2 and 1/2 hour choir practice, one infected person managed to infect 53 out of 61 others, two of whom later died, when it could be documented that there was no direct contact, short-range contact, or touching between all of those people.

But rather, they simply shared the same indoor space.

Also there was a hint that respiration and the type of respiration was important, in that these people were singing.

And that led to a dramatic increase in the rate of transmission compared to other airborne events.

There are many other examples one could go through.

There have also been, recently, some meta analyses of large numbers of cases, which further point towards indoor airborne transmission of COVID-19.

One recent such study looked at 7,300 cases of initial spreading of COVID-19 out of the epicenter of the outbreak in Hubei Province, China.

So they looked at 320 cities, to the first known cases in those cities outside of Hubei Province.

And they identified all the clusters of two or more transmissions.

And of those clusters-- there were 72 of them.

And they all occurred indoors.

And out of those, 80% were at home in people's apartments.

And 34% also included some public transportation.

And out of all those clusters of transmission, only one was documented to be occurring outdoors, consistent with a wide range of other evidence.

Moreover, there has been a cataloging of superspreading events such as the ones I've listed here.

And that list now numbers well over 1,000.

And out of all the superspreading events that have been documented, all of them have occurred indoors and involving large enough numbers of people that airborne transmission is the most plausible explanation.

So besides the overwhelming epidemiological evidence for airborne transmission of COVID-19, there is also growing physical evidence.

So first of all, other diseases that we've discussed in this course, such as tuberculosis, a bacterial disease, measles and the original SARS-CoV coronavirus, which are viral diseases, have all been established and believed to be transmitted through respiratory aerosols.

SARS-CoV-2 is a very similar coronavirus to SARS-CoV-1.

And so it's plausible that its mechanism of transmission would be the same, if not similar.

And indeed, there has been recent work demonstrating that infectious aerosol droplets could be isolated from infected patients with COVID-19.

And in particular, the most infectious droplets observed were in the aerosol range with radii less than 2 microns.

So the evidence is growing and frankly becoming overwhelming that the airborne route of transmission is important, if not dominant, for COVID-19.

So we will continue now by analyzing how to mitigate and model the transmission of a respiratory pathogen indoors.