PROFESSOR: So now let's summarize where we've come to in our analysis of short-range effects from respiratory jets relative to long range airborne transmission which we previously calculated.

And let's also think about what are the implications for policy.

And for personal decisions about safety during the pandemic.

So first of all, when masks are worn, we've already discussed the filtering effect of masks.

We've talked about how that brings a squared factor of the mask penetration factor which leads to a very substantial increase in the reduction in the transmission rate.

But there's another important factor when you have a mask, even a fairly poor mask, a cloth mask, it may not be so great a blocking aerosol particles but it's very good at blocking momentum so the fluid momentum that comes from just normal breathing is almost completely stopped by a mask.

Even a vigorous cough only lets some momentum through and a few droplets from more violent activities such as that.

So what's more typical in a case where people are wearing masks is that there is sort of some exhaled air slowly building up around you without very much additional momentum.

And as we've discussed that air is warmer and tends to rise.

And so typically the thermal plume of kind of the exhaled air rising above you a bit like a chimney and that's where the droplets initially reside.

We're not likely to directly infect anybody by that method, either because people aren't close enough or they aren't above the other person.

And then, of course, there are other flows in the room that we've discussed, which are often turbulent.

And those will transport the droplets everywhere and will lead to the well-mixed room as being the most natural and most accurate first approximation for the infection risk by another person who is also wearing a mask.

So I would argue that no strict social distancing is required in a mask situation.

So whether we're six feet or three feet, it's not going to give us substantially more safety if people are wearing masks.

And instead we should pay much more attention to the formula that I boxed here, which gives you an estimate of the long range transmission risks airborne which is equally there for everyone in the room.

And that must be considered for safety and also for contact tracing.

Now situation is very different without masks.

As we've seen without masks, we are imparting a lot of momentum to the fluid, the air.

Simply by breathing and certainly by talking or singing or exercising, we're really pushing the air around and launching those particles into the air.

And even at three feet or six feet there can be still a substantial risk.

Although as we said, the difference between three and six is not so great.

So one might consider switching to three.

On the other, hand, even six may not be enough protection you might need to be thinking about longer distancing.

And of course, there is always the airborne risk.

So at some point, you hit that point x_c where the airborne risk is comparable to the short-range risk.

And also there are people such as the guy I sketched back here which are not in the respiratory jet and probably have a lower risk than the average.

So it's definitely important to still consider the average risk coming from the long range guideline.

But one could add a correction to be very conservative for cases such as sketched here when this poor person is finding himself or herself in the respiratory jet for long periods of time.

So let's imagine there's a typical spacing, x bar, which would be sort of the worst case but still typical spacing one might expect of the people in the rooms.

If you think there's a certain situation where maybe two of the people might be five feet apart or four, three feet apart and facing each other for sniffing amounts of time, and then p jet is the probability that they are encountering each other's respiratory jets.

Or maybe put another way, the fraction of the time one person spends in another person's respiratory jet.

When that happens the transmission is just between two people.

It's not to the entire room.

So that's another very important factor to keep in mind, this factor of n, the occupancy, doesn't really come up in the social distancing model here when we're talking about the indoor reproductive number.

So to make a modified guideline, we can take the long range indoor reproductive number and add a short range correction.

We've already calculated what this looks like.

So if I write the guideline as n minus 1 tau is less than epsilon over the average beta, I can also restore what that means here.

Average beta times tau is the integral, time interval data, basically, of the transmission rate.

And so this fact that we've already calculated the ratio of the shortrange term to the longer term is x_c over x-- or x bar times p jet.

It's a very simple correction.

If we plug back in our estimates for this average beta then we arrive at this formula here.

The first term is the same guideline we already have.

And there's a new term now which, notice, does not involve n and doesn't have the mass factor, of course, as well.

But it involves the length, so social distancing.

And it involves the mouth area and the breathing rate.

The breathing rate now is also not coming in square because we're assuming that the breath is already providing this concentration.

And we're just looking at another distance downstream.

And the Qb is for the receiving person's inhaling breath rate whereas the QB squared comes from inhaling and exhaling and finding the steady state in the room.

And so we've already estimated how big this term is [? xc ?] over x might be anywhere from one to 100 or maybe even 1,000 if you let p jet be 1.

So if you stand facing another person continuously, this can be a large term and can actually dominate the other.

I'll notice there's an n there.

So still, there could be a balance.

But when you take into account that people are not always directly facing each other so much, then this number might be a lot smaller.

And I would argue that in many cases the dominant term is the long range one.

And the short range one is the correction.

But one should be aware of situations where the short-range effect could be dominant.

And so that must also be considered.

And this modified guideline here would be one way to take that into account.