PROFESSOR: So now let's use the results of our probabilistic model of transmission to see how we can modify our safety guideline to take into account different risk scenarios.

So our general result is that the expected number of transmissions in the room in a given time is given by the expected number of infected times susceptible times the mean transmission rate, which is the average beta times the time.

And we want this less to be than some tolerance.

And also, given the various approximations we've made where, for example, we have not let the number of susceptibles change-- people can be infected more than once, and we've neglected various aspects of the model in that way-- this should typically be assumed less than 1.

So we're always kind of thinking of transmission of being a rare event.

If we have lots of infected people in the room, lots of transmission going on, that's a more complicated situation which requires more sophisticated models.

But for purpose of guidelines, this is the limit that we want to think about.

But the different scenarios correspond to our different assumptions about I and S.

So first, I'll just remind you of what we've been doing until now, which is to limit spreading of the epidemic as a whole.

Thinking what if every indoor space were to impose the guideline, we're really thinking of the case where I is 1, and S is N minus 1, and then this expected number of transmissions is just the indoor reproductive number, which is, of course, just N minus 1 times beta tau is less than epsilon.

So that's the guideline that we've already been talking about because the I and the S here are now actually no longer random.

We're just saying let's just consider that situation.

And if everybody does that, then we are limiting the spread of the disease overall and should be hopefully fighting it.

What we'd like to talk about here is how to start with this kind of a restriction which gives us certain bounds on occupancy, ventilation, and other factors and think about, well, how would we actually remove that restriction as the prevalence of infection goes down?

So that's a bit of a different question, which is to limit transmission-- or maybe another way of saying that more precisely is new cases that are going to arise in this indoor space.

So now we're not just saying if an infected person enters, we don't want any new cases.

What if we just don't want new cases at all, including taking into account the low probability that somebody actually does enter this room who is infected?

So now I'll just remind you of the results from the last board for that situation with all the assumptions of the previous model.

So the expected number of I is now pIN.

The expected number of susceptibles N minus the expected number, which is qIN.

And importantly then, the expected value of I times S is pIqI times N times N minus 1, which was our result from the end of the board.

And so now when we write that we like the expected number to be much less than epsilon, expected total indoor transmissions, now notice instead of just an N minus 1 like we had before, we have these additional factors pQN.

And so we effectively divide by that.

So in this case, we can write our safety guideline taking into account the prevalence as epsilon divided by pIqIN.

And so this allows us as pI goes to 0 and qI goes to 1, so in other words, as the infection becomes less prevalent, then we can start modifying our guideline to increase this bound and, for example, a lot more people to enter the room or to increase their time in the room or to maybe turn down the ventilation a little bit.

And we can make changes like that.

It's typically considered to be a high prevalence infection when we're getting, let's say, in the range of maybe 100 to 1,000 infected per 100,000 people in the population.

So that would be 0.1 to 1.0 percent.

This is really considered usually quite high prevalence, actually.

So there's quite a few infected people around.

But in that case, if-- let's just say we had a situation with 10 people in the room just to give an example then.

What would this tell us in terms of increasing our time in the room or our occupancy?

Well, occupancy is here fixed.

But let's say time in the room or ventilation or other factors.

We can basically increase our N minus 1 tau, our cumulative exposure time, which is basically this indoor reported number that we're bounding.

This bound will increase or increases by 10 to 100 times because it's basically-- yeah.

This is an extra factor there.

So that means that if the thing was telling us that we could be in the room for five hours, maybe now it'll be 50 hours or even 500 hours actually depending on how low the prevalence actually gets.

And of course, as the prevalence goes down further, and the epidemic disappears, we start to completely relax our assumptions.

And we'll talk about that shortly.

There's a third risk scenario that is also of interest, which is to limit my personal risk for a given individual.

So in this case, we have a situation where I only care about myself, one particular person in the room.

So the number of susceptibles is now fixed at 1.

And the number infected people is potentially anyone else in the room.

So I'm worried about attending event or being in an office or some situation where there's a certain number of people.

And the number of infected that I would expect would be-- expected number infected would be-- well, it'd be exactly equal to pI times N minus 1.

So, basically, any other person than myself could be infected.

And so that's the expected number.

And of course, if S is fixed at 1, then this expected value I is also the expected value of IS.

So my transmission rate now has this factor.

And notice in this case, we get the same N minus 1 as before.

But there's this new factor PI here.

So that then tells me I could express the bound as the indoor reported number is less than epsilon divided by pI.

So, basically, we have these factors that come in when we talk about prevalence that take our previous bound that brings in all of the physical quantities related to the room, its ventilation, filtration, viral deactivation, time in the room, occupancy.

And we take those bounds.

And we can essentially rescale them with these values depending on how we are using the guideline.

Now, this is a very simple model but at least gives us a sense of how to make those decisions.

So, for example, let's consider a case like we did here where if the prevalence is in the range of 0.1% to 1.0%, which is actually a fairly high prevalence, then we could increase the bound on N minus 1 tau, our cumulative exposure time, by 100 to 1,000 times as a factor.

So if the guideline is telling us that you have five hours in this room, it might actually be more like 500 or even 5,000 for one particular susceptible person given the prevalence in the population.

So, basically, just want you to keep in mind that when applying the guideline, the basic ideas don't change.

We start with a bound on this reproductive number that brings in all of the physical quantities and disease quantities that we've been talking about.

But we also may modify that bound a bit depending on our risk scenario.