Understanding Virus Transmission at Work

Dr. Lydia Bourouiba shares her journey with MIT’s Fluid Dynamics of Disease Transmission Laboratory to help mitigate disease transmission in the workplace

In recent weeks, more business leaders around the world have been calling their people to return to the office after months of working from home. But as they prepare their return-to-work strategies, one thing is crucial for a successful transition: Employee safety and wellbeing must be at the forefront. In June, Steelcase began a relationship with MIT researchers to study disease transmission in work environments and bring science-based insights to the post-COVID workplace. Steelcase President and CEO Jim Keane had the opportunity to talk with Dr. Lydia Bourouiba, director of MIT’s Fluid Dynamics of Disease Transmission Laboratory, about her work and what we currently understand about mitigating disease transmission at work.

Jim Keane: What kind of research is your lab doing and how did you get introduced to this work?

Dr. Lydia Bourouiba: My lab specializes in looking at virus transport from one host to another for a range of relevant pathogens. I started looking at these problems after the SARS epidemic of 2003, when I began to realize we had very limited tools for public health and control of emerging pathogens. We particularly lacked tools for understanding the rules of the environment and the interaction of humans with the environment — in indoor spaces, for example — in leading to transmission of pathogens. And that’s how I started thinking about how to fully relate the questions that are critical and are bottlenecks in that chain of understanding and events.

What really motivates me is tackling these very multifaceted questions and discovering how better understanding the pathway of transmission could change the course of an epidemic, or even stop them in the first place. I was always very passionate about development, public health and social justice, but it took the SARS epidemic for me to clearly realize the importance of infectious diseases. It’s not something we can think of in separate pockets because society today is so interconnected. And that interconnectedness is beautiful, but it also means we are more vulnerable to virus transmission. And therefore, we need to think again about building a more resilient and equitable world where we can tackle these things at the source and deploy solutions at various socio-economic levels that will really make a big difference.

JK: How do you explain the complexities of virus transmission? Is avoiding it as simple as following the six-foot rule?

LB: The six-foot rule is a rule of thumb for how far droplets that are visible to the naked eye are able to deposit. But there's this whole other dimension of transmission where our exhalations — coughing, sneezing, talking and breathing — carry not only large drops, but a continuum of droplet sizes, even gaseous. So, the six-foot rule is really more for respiratory emissions that contain only large drops visible to the naked eye and fall in a ballistic way. The reality is more complex. Most exhalations are a continuum of drops, and we need to think about where we are in a given space, and what our interactions with the indoor space are in respect to the physics of that emission.

This isolated idea of the large drop and the distances associated with them comes from a long time ago, and in some sense has been the crux of many infection control efforts, in part because the smaller droplets — the aerosols — are more complex and a lot harder to quantify precisely, particularly in the past. But it doesn't mean they aren't there. Thankfully with the development of the last years, we have a very good grasp now of what this involves.

JK: How far is your lab from being able to build models informed by the research you're doing to accurately predict how sneezes, coughs and breaths might propagate in different kinds of spaces?

LB: The first step is modeling the exhalations themselves, which we have already done for violent exhalations and are continuing to work on for smaller momentum exhalations. It is very important to get those source models right because that is really what will precondition everything that is cascading downstream. The next phase is determining how to couple the source models in a realistic way with the indoor space. And that's what we have been engaged in more recently with Steelcase. And we are actually getting closer to validating those models against observations and very high-quality measurements. That will ultimately get us to a level where we can say this is quantitative. This is a realistic risk assessment given the physical processes that take place.

JK: How effective have you found masks to be in reducing the spread or the transmission of disease?

LB: There are a lot of differences between masks. High-grade masks like the N95 or the 300s are tailored to protect the wearer from the inhalation of particulates down to approximately 300 nanometers. Those are typically recommended for healthcare workers. Surgical masks are less efficient at protecting from inhalation of smaller drops, but more efficient than a fabric cotton layer, or just a bandana.

Now, it's also critical to think about your mask as a source control for the protection of others. Beyond the ballistic drops that are shooting outward, we also emit a gaseous cloud that moves through a path of least resistance with every exhalation. And so effectively wearing masks is about the combination of the material and the fact that it needs to be on properly. If you create a barrier that's very tight but isn't sealed properly, you might take some energy and momentum away from the cloud, but still allow aerosols to seep through the cracks in your mask.

Starting to think about entering a space where others are, the other key to keep in mind is the indoor air and space configuration. So if you are entering into a space that's extremely crowded and poorly vented, where even the cloud seeping from the sides of the mask could potentially reach others, that's a concern. If you're entering into a larger space, where distancing has been applied and occupancy is limited, we're talking about a lower risk.