Estimating risk of airborne COVID-19 with mask usage, social distancing

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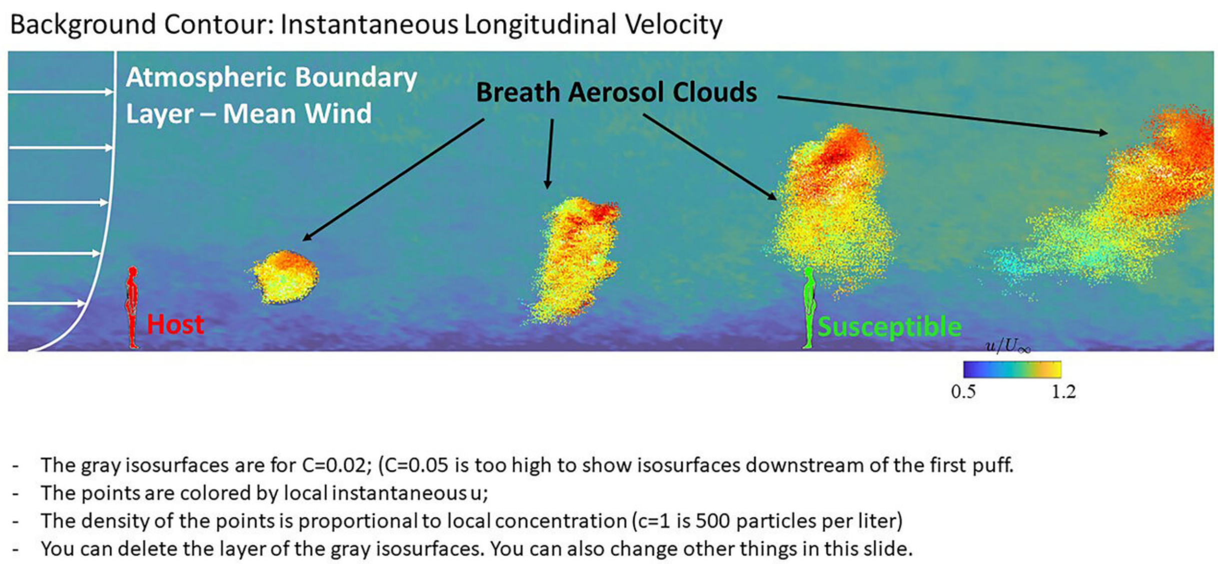

Large-eddy simulation results of the aerosol "clouds" generated by the breathing of an infected host in a turbulent boundary layer. Credit: Rajat Mittal, Charles Meneveau and Wen Wu

The continued increase in COVID-19 infection around the world has led scientists from many different fields, including biomedicine, epidemiology, virology, fluid dynamics, aerosol physics, and public policy, to study the dynamics of airborne transmission.

In *Physics of Fluids*, researchers from Johns Hopkins University and the University of Mississippi used a model to understand airborne transmission that is designed to be accessible to a wide range of people, including nonscientists.

Employing basic concepts of fluid dynamics and the known factors in airborne transmission of diseases, the researchers propose the Contagion Airborne Transmission (CAT) inequality model. While not all factors in the CAT inequality model may be known, it can still be used to assess relative risks, since situational risk is proportional to exposure time.

Using the model, the researchers determined protection from transmission increases with physical distancing in an approximately linear proportion.

"If you double your distance, you generally double your protection," said author Rajat Mittal. "This kind of scaling or rule can help inform policy."

The scientists also found even simple cloth masks provide significant protection and could reduce the spread of COVID-19.

"We also show that any physical activity that increases the breathing rate and volume of people will increase the risk of transmission," said Mittal. "These findings have important implications for the reopening of schools, gyms, or malls."

The CAT inequality model is inspired by the Drake equation in astrobiology and develops a similar factorization based on the idea that airborne transmission occurs if a susceptible person inhales a viral dose that exceeds the minimum infectious dose.

The model includes variables that can added at each of the three stages of airborne transmission: the generation, expulsion, and aerosolization of the virus-containing droplets from the mouth and nose of an infected host; the dispersion and transport via ambient air currents; and the inhalation of droplets or aerosols and the deposition of the virus in the respiratory mucosa in a susceptible person.

The researchers hope to look more closely at face mask efficiency and the transmission details in high-density outdoor spaces. Beyond COVID-19, this model based on the CAT inequality could apply to the airborne transmission of other respiratory infections, such as flu, tuberculosis, and measles.

More information: Rajat Mittal et al, A mathematical framework for estimating risk of airborne transmission of COVID-19 with application to face mask use and social distancing, *Physics of Fluids* (2020). DOI: 10.1063/5.0025476

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