How to COVID-proof the grocery line, classroom, and orchestra

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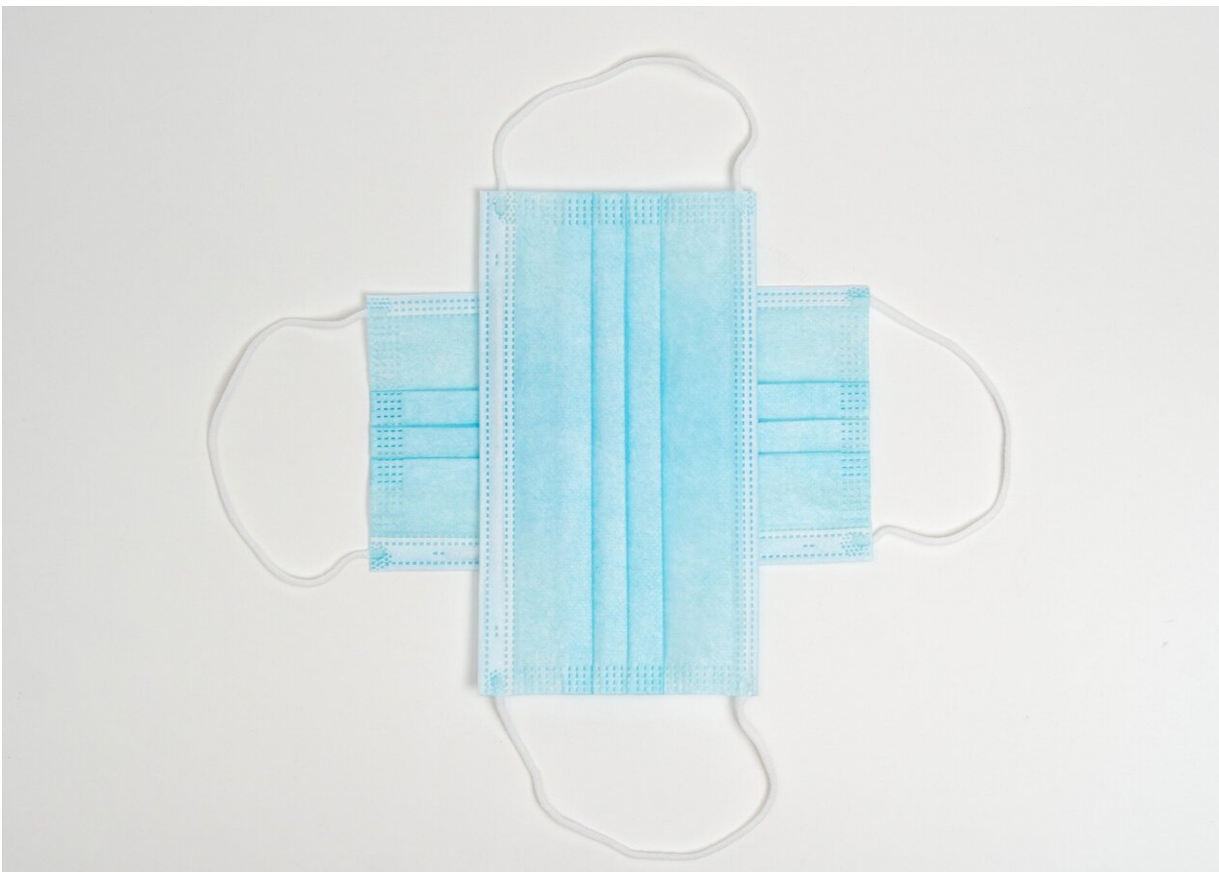

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Despite effective vaccines, it has become clear that SARS-CoV-2 will not fully disappear anytime soon. At the 74th Annual Meeting of the

APS Division of Fluid Dynamics, physicists and engineers will present innovative ways to avoid clouds of coronavirus whether waiting in line, going to class, listening to the opera, or encountering people elsewhere.

The researchers will share the latest results on reducing indoor viral transmission in crowded settings and take questions from journalists at a live virtual press briefing on Monday, November 22, 2021.

One of the researchers, University of Massachusetts Amherst physicist Varghese Mathai, and his group mounted 3-D-printed dummies on a conveyor belt to model airflow in a line of people.

They studied how waiting in a queue for prescriptions or groceries is more than an annoying activity—it is also a highly understudied location that can be a hotbed for pathogens spreading human to human.

"This study establishes some of the counterintuitive airborne transmission mechanisms that exist in public waiting lines—from voting lines, to supermarket and airport lines, to COVID-19 testing lines," said Mathai.

They found that periodic movements—when the entire line shifts one person forward—can actually cause aerosol transmission.

"We propose some strategies to reduce this cross contamination, measures that go beyond the six-foot guideline currently in place," said Ruixi Lou, an undergraduate who works with Mathai.

Heading into winter, another concerning location for viral transmission is classrooms. Opening windows is often impossible due to cold temperatures, and forced ventilation often prohibitively expensive. As a consequence, health risks are high.

"Dead zones can form in ventilated spaces and could become breeding grounds for airborne diseases," said Rao Kotamarthi, a Senior Scientist and air quality expert at Argonne National Laboratory. "If small aerosol particles containing a high viral density accumulate in these regions, an entire classroom could become infected."

Kotamarthi and his group from Argonne and the University of Illinois at Urbana-Champaign will share initial results at the meeting.

Simulations show that heating in the winter and air conditioning in the summer affect the size of dangerous dead zones in different ways. The temperature difference between incoming air and air inside a room reduces air mixing where students sit.

"We suggest cost-effective ways to improve the ventilation and mixing and stem the spread of airborne diseases in classrooms," said Kotamarthi.

Early in the pandemic, researchers discovered that singing and wind instruments spewed respiratory droplets aggressively. Now a collaboration between Princeton University, the Université de Montpellier, and the Metropolitan Opera Orchestra has developed new ways to safely enjoy live musical performance.

Professional opera singers and musicians performed live, and scientists tracked their exhaled air. Surprisingly, the singers' intense breath control meant they usually generated slower, safer air flows than an everyday person breathing would.

"Within an orchestra, we identify a few situations where rapid air jets might enhance the transport of pathogenic droplets and cause an enhanced risk of contamination. The rapid air flows can be strongly reduced by the use of a face mask and by covering the bell of the wind instruments," said Princeton postdoctoral engineer Philippe Bourrianne, who will present the study.

The study has been accepted by *Physical Review Fluids*.

Viral spread, however, is not limited to specific locations like an opera house. Wherever you encounter people, there is some risk that they—or you—could transmit a disease like COVID-19. So Alfredo Soldati, Director of the Institute of Fluid Mechanics at TU Wien, led a project to map virus exposure in different seasonal environments, with varying temperatures and humidity levels.

"By providing visualizations of the spatial distribution of the virus copies, we highlight the high infection risk associated with droplets that remain airborne in the near proximity of an infected individual," he said.

In a publication earlier this fall, Soldati and colleagues from the University of Padova, the Okinawa Institute of Science of Technology, and his own institution used simulations to create maps of where respiratory droplet clouds form in a wide range of scenarios.

"We have developed an effective yet simple framework capable of predicting the infection risk in different environmental conditions and respiratory activities," Soldati said.

More information: Philippe Bourrianne et al, Video: Air Flows in Opera, *73th Annual Meeting of the APS Division of Fluid Dynamics - Gallery of Fluid Motion* (2020). DOI: 10.1103/APS.DFD.2020.GFM.V0067

Jietuo Wang et al, Short-range exposure to airborne virus transmission and current guidelines, *Proceedings of the National Academy of Sciences* (2021). DOI: 10.1073/pnas.2105279118

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