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COVID-19 Precautions Help Make Music That's Beautiful *and* Safe

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When COVID-19 lockdowns began in March 2020, musicians around the world weren't sure whether they could safely play their instruments in front of an audience. Music teachers at all grade levels also wondered whether they could instruct a room full of students without spreading infection. Would in-person music education have to be put on hold indefinitely?

Harmonizing

To find answers, James Weaver, EdD, director of performing arts and sports for the National Federation of State High School Associations, and Mark Spede, DMA, national president of the College Band Directors National Association, sought help from Shelly Miller, PhD, MS, a professor of mechanical engineering and faculty in the environmental engineering program at the University of Colorado. Miller teamed up with Jelena Srebric, PhD, professor of mechanical engineering at the University of Maryland, and Jean Hertzberg, PhD, associate professor of mechanical engineering at the University of Colorado, to measure the aerosols produced during musical performances, visualize their flow around the room, and test ways to reduce the risk of SARS-CoV-2 transmission.

To pay for the [study](#), published in the American Chemical Society journal *ACS Environmental Au*, Weaver and Spede raised \$330 000 over 22 days from 125 arts organizations around the world. "[The pandemic] brought many divergent arts organizations together with a common goal," Spede said in an interview.

The Backstory

Early on, the role of aerosols in spreading SARS-CoV-2 wasn't clear. But outbreaks [linked](#) with indoor gatherings suggested that people could be infected solely through aerosol exposure. A Washington State chorus practice that became a superspreader [event](#) in mid-March 2020 highlighted the risk of aerosol transmission linked with performances:

- Sixty-one people, including 1 who had COVID-19 symptoms, attended the 2.5-hour rehearsal.

- At least 52 developed confirmed or suspected infections, 3 were hospitalized, and 2 died.



University of Colorado graduate student Tehya Stockman places a homemade bell cover made from medical mask material to test for the effectiveness of lowering aerosols.

Miller and her colleagues [analyzed](#) the event and found the virus most likely spread via aerosols. Their data also showed that:

- The infection rate could have been reduced from 85% to less than 10% if the rehearsal had lasted 30 minutes instead of 2.5 hours.
- Multiple mitigation strategies like wearing masks, limiting rehearsal time, using a portable air filter, and improving ventilation in the rehearsal room could reduce the risks even further.

Instrumental Questions

"We knew that singing was risky because there were confirmed outbreaks, but we knew nothing about musical instruments," Tehya Stockman, the study's lead author and a graduate student at the University of Colorado, said in an interview.

Measuring Plumes

The investigators quickly launched the Performing Arts Aerosol [Study](#) to learn more about aerosol plumes released from

instruments and during other types of performances. "We were really trying to think about what mitigation strategies would work for kindergarten through college students learning music," Stockman said. In the study, she and her colleagues:

- Used air cleaners with high-efficiency particulate air filters to lower ambient particles and reduce potential background aerosol levels.
- Invited 2 singers, 1 theater performer, and 12 instrumentalists who played 5 different woodwind instruments and 4 brass instruments to participate.
- Measured plumes of aerosols and carbon dioxide emitted during each performance.

The results showed that the instruments produced more aerosols than speaking and about the same amount as singing. "We learned that the plumes are quite complex," Stockman said. "They are very transient, and the aerosol concentration varies quite a bit from instrument to instrument."

Masking Matters

Next, they tested several mitigation strategies that included masking the instruments. One approach used a 3-layer surgical mask secured with a rubber band over the bell of small instruments. Another covered the bell of larger instruments with filtering material having a minimum efficiency reporting value of 13 (MERV 13), which is recommended for non-health care facilities. These techniques were able to:

- Reduce aerosol concentrations to amounts comparable with background levels.
- Decrease the distance that aerosols project beyond the bell, from 12 in to 3 in.
- Slow the speed of an initial aerosol plume, allowing ambient air to dilute it before reaching performers.

"A bell cover reduces the risk enough to make it a viable strategy for people to use," Stockman said. Mutes, which fit into an instrument's bell to change its tone, allowed aerosols to escape "like a thumb on a garden hose," Spede noted.

Using computer modeling, Stockman and her colleagues also found that performing outdoors and limiting a performance's duration can protect musicians from aerosol accumulation. "Aerosol can build up over time much more quickly in an indoor space," she noted.

The team's calculations showed that combining prevention strategies was the most effective approach, providing the following risk-reduction effects:

- Wearing masks and keeping performances to 30 minutes or less kept the risk of infection below 10%.
- Performing for more than 30 minutes, even with masks, led to infection risks greater than 10%.

Practicing Precautions

With help from Weaver and Spede, the researchers developed [recommendations](#) for multiple precautions that could be applied in music classrooms. "[Mitigation strategies] had to be easy to use, easy to

access, and relatively affordable," Weaver said in an interview. They include:

- Having singers, theater performers, and musicians wear well-fitting surgical masks while singing or speaking.
- Using bell covers made of a 3-ply surgical mask for small instruments or a MERV 13 filter inside a Spandex cover for larger instruments.
- Maintaining US Centers for Disease Control and Prevention-recommended social distancing between performers and audience members.
- Limiting performances to 30 minutes indoors and 1 hour outdoors. A recent [update](#) extended indoor performance time to 50 minutes at venues with 3 air exchanges or more per hour.
- Performing outdoors when possible.
- Improving ventilation indoors by opening windows, using high-efficiency particulate air cleaners, or increasing the ventilation system's air exchange rate.

Real-world Results

To assess the real-world effect of implementing the recommendations, Spede and Weaver teamed up with Whitney Huang, PhD, an assistant professor of math and statistical sciences at Clemson University. Their [survey](#) of 3000 schools with in-person music instruction last year showed that nearly 2800 used some of the recommended precautions.

Based on SARS-CoV-2 transmission patterns in the schools, the trio concluded that the chance of contracting COVID-19 during rehearsal with the recommended mitigations in place is about 1 in 2 million compared with about 1 in 270 000 without the precautions.

"If we can get used to using these mitigations, we can continue operating at very low risk," Spede said. ■

Conflict of Interest Disclosures: None reported.

Note: Source references are available through embedded hyperlinks in the article text online.