Musical Instruments and Risk of COVID-19: Literature Review as of September 15, 2020

Stephanie Schulte, Kenya Moyers and Zachary Weber on Behalf of the Safe Campus & Scientific Advisory Committee

Currently, there is no formally published evidence related to either the survival of coronavirus on the surface of various instruments or whether playing an instrument increases the amount of droplets or aerosols in the air that could potentially carry the virus. However, there are studies in progress, with some sharing of preliminary findings via videos and web pages. Several studies have documented bacterial, mold, and yeast presence/colonization in a variety of both woodwind and brass instruments, sometimes connected to serious health problems such as hypersensitivity pneumonitis. Below is a concise summary of the literature that was found.

Bacterial and Fungal Contamination

Using a targeted search approach, several studies describing the presence of bacteria, mold, and yeasts in both woodwind and brass instruments were found.[1-6] In all studies examined, a very high percentage of instruments sampled were contaminated, and this contamination was typically worse in instruments with reeds. Three cases[1,3,4] reported hypersensitivity pneumonitis, presumably connected to the fungal contamination found in the patients' instruments, which were both brass and woodwinds. One study examined survival of bacteria on instruments,[2] which ranged from 24 hours to 13 days and was dependent on how far in the past the instrument had been played. These studies highlight the need for regular cleaning and disinfection of instruments, which is especially important if instruments are shared between multiple players.

Fluids from Water Valves or Condensate from Woodwinds

One study examined whether fluids emptied from brass instruments via water keys onto rehearsal room floors posed an infectious threat to band members.[7] The water keys of 30 brass instruments were swabbed and analyzed by a commercial lab. This study predominantly found a bacteria common to the environment which the authors state is not generally pathogenic with a few exceptions and did not think the fluids posed an infectious threat in healthy people. The same authors also conducted a similar study in woodwinds.[8] This study found a larger variety of bacterial species, many of which were described as opportunistic and generally not pathogenic in health individuals, although a few instruments had bacteria associated with severe infections.

Studies and Guidance Directly Connected to COVID-19

Currently, there is a lack of systematic study and quantitative information of the aerosol generation during the use of woodwinds, which is crucial for offering risk assessment and the corresponding mitigation strategies for the reopening of these activities.[9] Data was collected from 15 musicians in the Minnesota Orchestra to identify aerosol generation from a variety of wind instruments. The musical instruments used included trumpet, bass trombone, French horn, tuba, bassoon, piccolo, flute, clarinet and bass clarinet. Instruments were categorized into low, intermediate, and high-risk levels based on comparison of their aerosol generation with those from normal breathing and speaking. Tubas, which are considered low-risk, produce fewer aerosols than normal breathing. The trumpet, oboe, and bass

trombone generate more aerosols than speaking. Aerosol generation can be affected by the changing dynamic level, articulation pattern, the normal respiratory behaviors of individuals, and even the usage of some special techniques during the instrument play.[9] Results showed that slurred play produced more aerosols than well-articulated instrument play. For woodwind instruments, their aerosol concentration seems to be strongly influenced by its mouthpiece design.

At least two European investigations connected to musical instruments and COVID-19 risk are underway. The Bamburg Symphony Orchestra in Germany is working with scientists to determine aerosol spread from playing an instrument and have released a short video[10] and a report of findings to date.[11] Of note, this work appears to be within a typical orchestra setting and may not be meaningful for a marching band setting since it is a much more athletic activity. In their report, they note that no air movement was detected at a distance of 2 meters from the instrument mouthpieces. This does not address the issue of aerosols generated by playing the instruments or the deep inhalation and exhalation by players. Measurements of aerosols are still pending per the May 19 report. Additionally, the Institute of Fluid Mechanics and Aerodynamics at University of the Bundeswehr in Munich have released a video on YouTube reporting their findings from flow experiments.[12] As of today, a formal peer-reviewed report of this work has not been found. The recommendations from the video are to only sing or play instruments in large, well-ventilated rooms with adequate social distancing. They also advocate for the use of popscreens to act as a physical barrier to droplets, especially for singing and small-belled instruments. This video largely focuses on droplets and does not address aerosols.

Two national band organizations in the United States are also addressing the aerosols question, with preliminary results released in July (https://www.nfhs.org/media/4029952/preliminary-testing-report-7-13-20.pdf).[12] The study is examining airflow, aerosols, particle size, and concentration of particles using a Schlieren Test, condensation particle counts, and aerodynamic particle sizer spectrometer measurements. Bearing in mind the preliminary nature of the available results, there does appear to be a marked increase of particle concentration with playing compared to sitting still or reading. Several practical recommendations are made for rehearsals. These include wearing masks at all times except when playing (and possibly using a mask with a slit while playing), not allowing talking without a mask and keeping volume of speech low, using bell covers for instruments, and having instructor use most efficient mask (currently surgical mask due to N95 supply chain issues) and microphone/amplifier in order to keep their speaking volume low. Additionally, they recommend social distancing of 2 meters/6 feet while noting that trombone players need an additional 3 feet (9 x 6 feet space), optimizing HVAC systems for air exchanges and filtration, potentially using air purifiers of appropriate size and function, and utilizing outdoor rehearsal spaces where possible. One of the sponsors of this study, the National Federation of State High School Associations, has also released guidance for marching bands on July 9, 2020, which emphasizes pre-rehearsal testing, mask wearing, and other hygiene recommendations common to coronavirus prevention.[13]

Different instrument families produce different-sized airborne particles, with varying characteristics. Researchers believe that it is crucial to understand the extent to which airborne particle production takes place to assess the extent to which instruments might assist the spread of viruses like SARS-CoV-2.[14] In this study 7 volunteers, each with a different brass instrument, played for 60 seconds. Volunteers breathed strongly into a particle counter collector funnel to compare the effect of playing with no

activity. A polycotton material cover was placed over the instruments bell ends to assess the possibility of a mitigating barrier. Particles that were expelled from instrument or mouth were counted using a Laser Particle Counter and classed as either Aerosol type particles, which were 5µm, or Droplet type particles >5µm, as these size differences are important in analyzing the risk of viral transmission. The mean concentration across all instruments measured was found to be $1.21x10^7$ $\pm1.03x10^6$ Aerosol type particles/m^3 and $1.43x10^4$ $\pm9.01x10^2$ Droplet type particles/m^3. The mean measurement for the same subjects when breathing was $1.61x10^7$ $\pm1.33x10^6$ Aerosol type particle/m^3 and $5.45x10^3$ $\pm1.20x10^3$ Droplet type particles/m^3.[14] Fewer aerosol particles are produced while playing than while breathing. For droplet particles, there are more produced while playing than while breathing. The use of the mitigating barrier resulted in an Aerosol particle reduction of 78.5% and a Droplet particle reduction of 63.8%.[14]

1. Davidson J, McErlane J, Aljboor K, et al. Musical instruments, fungal spores and hypersensitivity pneumonitis. *QJM.* 2019;112(4):287-289. doi: 10.1093/qjmed/hcz020
2. Marshall B, Levy S. Microbial contamination of musical wind instruments. *Int J Environ Health Res.* 2011;21(4):275-285.
3. Metzger F, Haccuria A, Reboux G, et al. Hypersensitivity pneumonitis due to molds in a saxophone player. *Chest.* 2010;138(3):724-726. doi: 10.1378/chest.09-2991
   Metersky ML, Bean SB, Meyer JD, et al. Trombone player's lung: a probable new cause of hypersensitivity pneumonitis. *Chest.* 2010;138(3):754-756. doi: 10.1378/chest.10-0374
4. Dalphin JC, De Vuyst P, Lefebvre A, et al. Fungal contamination of wind instruments: Immunological and clinical consequences for musicians. *Sci Total Environ.* 2019;646:727-734. doi: 10.1016/j.scitotenv.2018.07.284
5. Banzhoff S, Caffier PP, Del Mar Ropero M, Gross M, Menzel G, Salmen T. Medical issues in playing the oboe: A literature review. *Med Probl Perform Art.* 2017;32(4):235-246. doi: 10.21091/mppa.2017.4040
6. Mobley J, Bridges C. Wind ensemble infectious disease risks: A microbiological examination of water key liquids in brass instruments. *Tex Public Health J.* 2015;67(2):16-18.
7. Mobley J, Bridges C. Wind ensemble infectious disease risks II: A microbiological examination of condensate liquids in woodwind instruments. *Tex Public Health J.* 2016;68(4):6-10.
8. Bamberger Symphoniker: Wissenschaftler messen Aerosolausstoß. https://www.br.de/nachrichten/bayern/bamberger-symphoniker-wissenschaftler-messen-aerosolausstoss,Ry6T6OU. Updated May 5, 2020. Accessed June 29, 2020.
9. He, R., Gao, L., Trifonov, M., & Hong, J. (2020, January 01). Aerosol Generation from Different Wind Instruments. *medrxiv.* Retrieved September 15, 2020, from https://www.medrxiv.org/content/10.1101/2020.08.03.20167833v3.article-info
10. Spahn C, Richter B, Schuster A, Hengel H, Burkle H. Risikoeinschätzung einer Coronavirus-Infektion im Bereich Musik – zweites Update vom 19. Mai 2020 (Risk assessment of a coronavirus infection in the field of music - second update from May 19, 2020). https://www.mh-freiburg.de/hochschule/covid-19-corona/risikoeinschaetzung. Updated July 1, 2020. Accessed July 15, 2020.
11. Institute of Fluid Mechanics and Aerodynamics, University of the Bundeswehr. Making music during the SARS CoV 2 pandemic. https://www.youtube.com/watch?v=BYo3wlWUDDM&feature=youtu.be. Updated May 17, 2020. Accessed May 29, 2020.

12. Spede M, Weaver J. Unprecedented international coalition led by performing arts organizations to commission COVID-19 study. https://www.nfhs.org/articles/unprecedented-international-coalition-led-by-performing-arts-organizations-to-commission-covid-19-study/. Updated July 15, 2020. Accessed July 15, 2020.
13. NFHS Sports Medicine Committee, NFHS Music Committee. Guidance for a return to high school marching band. https://www.nfhs.org/media/3812337/2020-nfhs-guidance-for-returning-to-high-school-marching-band-activities.pdf. Updated July 9, 2020. Accessed July 15, 2020.
14. Parker, A., & Crookston, K. (2020, August 04). Investigation into the Release of Respiratory Aerosols by Brass Instruments and Mitigation Measures with Respect to Covid-19. *medrxiv.* Retrieved September 15, 2020, from https://www.medrxiv.org/content/10.1101/2020.07.31.20165837v1