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Aerosolization notes

1. 2 types of transmission of SARS-CoV-2
    a. Direct—person to person/handshake or INDIRECT--via fomites on objects around us then we touch our face/mucus membranes
    b. Airborne—3 sizes of particles
        i. Droplets, largest particle emitted from respiratory tract (>5 micron) (more of these in a cough than speech)—probably minority of transmission (recent opinion by Malcolm Butler, MD)
        ii. Small particles, <1 micron, carry little virus but float for hours
        iii. Most concerning are medium sized 1-5 micron particles: Evaporate and become respiratory droplets called <u>droplet nucleii</u> (<5 microns)
            1. They immediately dry and shrink in the air, concentrating their viral load. May contribute to majority of transmission. float for hours
        iv. Long established: breathing and speaking lead to aerosolized particles
            a. Typically small
                i. From alveoli of lungs (smallest air sacs where oxygen exchange occurs) “fluid film burst” in alveoli
            b. Laryngeal and possibly Oral produce the medium sized particle
                i. Vocal folds also have a fluid film and why voicing and singing produces more medium sized aerosols.
                ii. This is why singers most likely need to mitigate risk
    c. Virology
        i. Average viral titer and susceptibility of the host are two primary issues
            1. Viral load per sneeze, breathe, song etc. to cause infection is important
            2. Minimal infectious dose for an individual at risk is second piece
                a. Neither are known for COVID-19, theoretically 1 viral fomite may be enough in the right person.

REF: Asadi S, Bouvier N, Wexler AS, Ristenpart WD. The coronavirus pandemic and aerosols: Does COVID-19 transmit via expiratory particles? Aerosol Science and Technology. 2020 Jun 2;54(6):635–8.

    d. Good analogy by Dr. Malcolm Butler recently about why everyone wearing a cloth mask is the next best thing to a vaccine. The virus fomite has to find the right susceptible person, infect that person through the respiratory mucosal route and then be in enough concentration to overcome their defenses.
        i. Time in contact with the virus and the viral load in the environment increase the virus’s chance of infecting that person.
        ii. Because large droplets and medium sized particles are stopped by a cloth mask, small particles will still escape the mask into the air; but remember, they are less infectious.
    e. Aerosol science

i. How particles move through the air is important
    1. Proximity of two individuals in a room with air movement may blow particles away from a close individual and towards another person further away
    2. Particle size affects how they settle:
        a. Larger particles /droplets have a higher viral load
            i. They can't travel as far or easily as deep into respiratory tract of nearby individuals
            ii. They fall within 6 feet typically and settle in the environment sooner
    3. Room air turnover and size are thus key to removing floating aerosolized particles. Plexiglass between singers will catch some but not all aerosolized particles. Singers move, distance cannot be guaranteed from plexiglass.
        a. Then up to time, room size, air turnover, susceptibility to disease etc.
        b. Distance of 6 feet between is not enough, even with masks to prevent the right aerosols from floating farther away (Setti et al)
            i. Even small particles that don't get stopped by cloth masks can get concentrated in a small space without good air turnover
        c. Face to face posture transmission carries biggest risk indoors.

REF: Ai and Melikov. Indoor Air. 2018;28:500–524.

f. Loudness
    i. Asadi demonstrated that increased vocal amplitude (loudness) led to increased aerosolization
        1. Particle size was slightly larger with louder speech, possibly from contribution from vocal folds. However overall particle size distribution was same as with softer speech
    ii. Some people may be speech supermiters who emit particles at rates an order of magnitude higher than others.

REF: Asadi S, Wexler AS, Cappa CD, Barreda S, Bouvier NM, Ristenpart WD. Aerosol emission and superemission during human speech increase with voice loudness. Scientific Reports [Internet]. 2019 Dec [cited 2020 Jun 28];9(1). Available from: http://www.nature.com/articles/s41598-019-38808-z

g. Symptom free period
    i. 2-3 days before symptoms particles are being expelled in droplets and aerosols (He et al)
    ii. Risk for asymptomatic spread (no fevers, malaise, cough etc.)