Aerosol or droplet: critical definitions in the COVID-19 era

To the Editor,

In a recent publication by Workman et al.,[1] the authors examine spread of fluorescent particles during a range of endonasal procedures using a cadaver model and propose guidance on risk of aerosolization with these procedures. This study was designed to measure droplet spread, not aerosol deposition or settling. Infectious aerosols are defined as particles under 100 μm in diameter that are suspended in a gas and can be respired.[2,3] Aerosol particles between 10 and 100 μm tend to deposit in the upper airway whereas particles under 5 to 10 μm in size are the airborne particles that can bypass the upper airway and penetrate deep into the lungs.[2,4,5] Aerosol movement, deposition, and surface settling times are generally influenced by air flow rates in the local environment.[2,4] Simulation of aerosol movement in an exam room demonstrated that aerosol can spread throughout the room within 5 minutes and aerosol clearance is highly dependent on the number of air changes per hour.[6] These fundamental properties of aerosols together with characteristic spread patterns for droplets form the basis for guidelines for personal protective equipment (PPE) use for airborne vs droplet precautions.[3]

Workman et al.[1] used an atomizer to create a fluorescent layer of particles ranging in size from 30 to 100 μm in diameter. However, the particles produced during the simulation of aerosol generation by the atomizer alone and during the endoscopic procedures are not limited to this size. The fluorescent particles can attach to other larger particles through hydrostatic forces, including moisture inside the cadaver, or random-sized particles generated by the described endoscopic procedures. These aggregate particles are then expelled from the nose as droplets based on the velocity of the initial spray or net velocity of air movement generated by the endoscopic procedure. This is supported by the results of Figure 3A in Workman et al.[1] In Figure 3A, the size of particles detected outside the model system after expulsion of fluorescent particles generated by the atomizer are in the range of hundreds of microns to about 1500 μm in size, well outside the defined range of infectious aerosols, which are less than 100 μm in diameter. This is also not a limitation of the reported detection limit, because the authors report an estimated detection limits down to 20 μm.

The points above are not merely a matter of semantics; rather, these definitions are critical to understanding the physical behavior of these micrometer-scale and nanometer-scale particles, and their propensity to linger in the air or spread across and contaminate the local environment. This is of particular importance for coronavirus disease 2019 (COVID-19) because the severe acute respiratory syndrome-coronavirus-2 (SARS-CoV-2) spike protein receptor, angiotensin-converting enzyme 2 (ACE-2), is highly expressed on type II airway pneumocytes[7,8] and SARS-CoV-2 can survive in a closed environment as an aerosol for at least 3 hours with an estimated half-life in aerosol of 1 hour.[9] When considering the guidance on risks associated with an aerosol-generating procedure, we need to remain cognizant and account for the multiple components involved in the spread of infection with SARS-CoV-2. Variables to consider include: (1) the mechanism of spread (contact, droplet, or aerosol); (2) the minimum viral titer and length of exposure required to cause an infection with these various modes of spread; (3) factors that would increase host susceptibility to infection by SARS-CoV-2; and (4) host factors that would lead to a severe form of COVID-19. Although we are learning more about COVID-19 daily, many of the answers to these questions are currently unknown. The adapted face covering intervention to limit droplet spread demonstrated by Workman et al.[1] is likely to be an effective, practical method for limiting droplet and contact spread of infectious particles, in an analogous fashion to data supporting wearing masks in public reducing risk of disease transmission.[10] However, as Workman et al.[1] note in their discussion, more rigorous studies are required before we can determine the relative safety of various aerosol-generating procedures.

Sincerely,

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