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Seconds after Aerosolisation: The Impact of Relative Humidity on Airborne Influenza Virus

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Influenza A virus (IAV) is a major respiratory pathogen, causing around 650,000 deaths annually. A significant transmission pathway for IAV is via expelled respiratory aerosol. For successful transmission via the aerosol route, IAV must remain infectious following transport from an infected host to a susceptible individual. Many environmental factors may affect IAV infectivity, including ambient relative humidity (RH), temperature, gas-phase composition, and UV exposure. However, there is a lack of understanding of how different environmental conditions impact IAV infectivity in the first seconds to minutes following aerosolisation.

To fill this research gap, we employed a flow tube setup in which a virus-laden aerosol was generated from a liquid suspension, mixed with an RH-controlled dilution airflow, and passed through a stainless steel tube. The aerosol exposure time within the flow tube was ~8 seconds, and the aerosol was collected in 4 size fractions using a BioCascade (Aerosol Dynamics Inc.) in conjunction with a BioSpot (Aerosol Devices). The BioCascade allows aerosols with aerodynamic diameters >10 μm, 4-10 μm, and 1.5-4 μm to be sequentially sampled into liquid media via a series of impaction stages. The BioSpot collect aerosol down to 5 nm via condensational growth and impaction into liquid media. Collected samples are assessed for the presence of infectious virus using a plaque assay, a standard method that quantifies infectious virus by measuring visible cell damage. Viral genome copies within the sample were also assessed using RT-qPCR. Finally, aerosol concentration and size distributions were measured using an Aerodynamic Particle Sizer (APS, Model 3321, TSI Inc.) and a Scanning Mobility Particle Sizer (SMPS, TSI Inc.).

Our preliminary results indicate that the bioaerosol nebulising generator (BANG) produces virus-laden aerosols with the majority of aerosol mass in the 1-4 μm aerodynamic diameter size range. This is also reflected in the RT-qPCR results obtained using the biocascade impactor. When averaged across all RHs tested, the majority of viral genomes (72.14±3.31%) were detected in the 1.5-4 μm aerodynamic diameter impactor stage. This is followed by the
<1.5 μm, 4-10 μm, and >10 μm stages, where 16.44±2.24%, 11.01±5.49%, and 0.41±0.02% of viral genomes were detected, respectively. To understand the influence of each tested condition on IAV viral infectivity will be quantified using a plaque assay and normalised to the viral genome copies measured for each impactor stage. This analysis will elucidate the impact of RH on IAV infectivity within the first seconds of aerosol generation and resolve the influence of aerosol size on viral decay.