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Do the varying drying rates influence rhinovirus infectivity?

Objective: Human rhinovirus is the most common cause of the common cold worldwide (1). It has been shown that a substantial part of the airborne viruses is found in aerosol particles in the range of 1-4 μm (2). Studying the infectivity of aerosol particles in this range is, however, challenging; therefore, not many studies have been conducted on their infectivity. The aim of this work is to investigate the infectivity of aerosolized rhinovirus in particles <5 μm under varying levels of relative humidity (7%, 50%, and 80%-90%).
Methods: We performed aerosolization and collection of rhinovirus in a laboratory setup previously described by Alsved et al. (3). A flow tube was placed inside a laminar flow (LAF) cabinet to avoid any contamination during the experiment. The BioAerosol Nebulizing Generator (BANG) was used to generate the aerosol of rhinovirus, which was introduced into either a long or short exposure tube under different levels of relative humidity (RH). At the other end of the exposure tube, the bioaerosol was collected by impaction in three different size fractions using the BioCascade (Aerosol Dynamics Inc.): >10 μm, 4-10 μm and 1.5-4 μm. The remaining particles <1.5 μm continued to the BioSpot-VIVAS (Aerosol Devices) where they were grown to larger droplets by water condensation before impaction into liquid. In addition, an aerodynamic Particle Sizer (APS, Model 3321, TSI Inc.) and a Scanning Mobility Particle Sizer (SMPS, TSI Inc.) were used for analyzing the size distribution of the bioaerosol. To ensure that we were measuring the dry size of the particles, a silica drier was connected before the APS and SMPS. Additionally, the viral load of the collected bioaerosol samples was determined by quantitative polymerase chain reaction (qPCR). Since qPCR only detects the total presence of cDNA in a solution and does not assess the infectivity of the virus, the infectivity of rhinovirus was assessed by measuring the cytopathic effect in HeLa cells, using the 50% Tissue Culture Infectious Dose (TCID50) and the Most Probable Number (MPN) method. To minimize the influence of small variations in aerosol concentration on virus infectivity results, MPN values were normalized by the total aerosol mass measured by the APS during the sampling time.
Result: In the experiment when all particle sizes were collected with the BioSpot, our results suggest that airborne rhinovirus infectivity was about 50% higher at RH above 80% compared to a 7% RH, however, it was not statistically significant. When collecting the aerosol in different size fractions using the BioCascade and the BioSpot, the smallest particle size fraction (<1.5 μm) was significantly more infectious than the two larger size fractions (1.5-4 and 4-10 μm) when aerosolized at 7% RH (t-test, $p<0.05$). No difference in infectivity was found when comparing larger particles to each other (4-10 μm vs 1.5-4 μm). The infectivity of the largest particle size fraction (>10 μm) was below the detection limit of the MPN assay.
Conclusion: Based on the experimental results, aerosol at high humidity and particles smaller than 1.5 μm contained more infectious rhinovirus per aerosol mass than aerosol in low humidity and in particles >1.5 μm. There is a possibility that the collection methods, direct impaction for particles >1.5 μm versus condensational growth prior to impaction for <1.5 μm, influenced the result. So far, experiments have only been conducted once, so repeating the experiment is essential to be able to draw any firm conclusions. In addition, we will develop a copy standard for the qPCR to be able to normalize the infectivity by the virus copy number.
References:
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