THE UNIVERSITY of NORTH CAROLINA at CHAPEL HILL

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Modeling insights into SARS-CoV-2 respiratory tract infections

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Abstract. I and many collaborators, postdocs, and students from many disciplines have explored lung mechanics and disease pathology for over 2 decades in a pan-university effort called the UNC Virtual Lung Project. In the last decade with the Sam Lai lab we have explored how viruses "traffic" in mucosal barriers, including the human respiratory tract (RT). These efforts have focused on understanding the primary respiratory defense — mucociliary clearance – and secondary defense from antibodies. Then along came the novel coronavirus SARS-CoV-2, requiring a major pivot to a pre-immunity study of the human RT. Over the past 20 months we developed a computational model that incorporates detailed anatomy and physiology of the RT and best, evolving, knowledge about SARS-CoV-2. We model virus mobility in airway surface liquids (ASL), infectability of epithelial cells and their replication rates and duration of infectious virions. We then simulate outcomes from inhaled SARS-CoV-2 depositions anywhere in the RT, likelihoods of clearance versus infection, and propagation of the viral load and infection. Results shed mechanistic insights into clinical observations prior to immune protection from SARS-CoV-2. Next we give some insights / predictions about the delta variant and antibody protection.This work is a collaboration w/ Ric Boucher, Director of the Marsico Lung Institute (MLI), Ronit Freeman of APS, Sam Lai of the School of Pharmacy, and Ray Pickles of the MLI. The mathematical modeling results are with Alex Chen, Cal State Dominguez Hills, Tim Wessler, UNC and UMichigan postdoc, and Kate Daftari and Jason Pearson, UNC PhD students.