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Fluid dynamic insights into the deposition of virus in deep lung
ARANYAK CHAKRAVARTY, School of Nuclear Studies and Application, Jadavpur University, MAHESH V. PANCHAGNULA, Department of Applied Mechanics, IIT Madras, NEELESH A. PATANKAR, Department of Mechanical Engineering, Northwestern University — The impact of airborne viruses like SARS-CoV-2 in a human lung depends on the deposition and clearance of the inhaled viruses, among other factors. The viruses get deposited in the mucus layer of the lung. The mucus layer motion toward lower generations, caused by ciliary beating, clears the lung of the deposited viruses. Thus, the combined effect of the deposition and clearance mechanisms is critically important to determine infection by viruses. The deposition and clearance of airborne viruses has been individually investigated. In this work, a coupled analysis considering both mechanisms is done. We developed a coupled Weibel-like numerical model for the airways and the mucus which solves for virus-laden aerosol concentration in the airways and virus concentration in the mucus. The viruses are observed to be deposited in the deep lung for aerosol sizes less than 3 micron. Clearance rate of the deposited virus is observed to depend on the initial deposition location, mucus advection and breathing cycle. While depositions in the upper lung are cleared in a short duration, substantially longer times are required for clearance of the deep lung depositions. Weaker mucus advection in the deep lung and a longer breathing cycle is observed to substantially increase the clearance time.

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