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A Reduced-dimension Model of Liquid Plug Propagation in Tubes DAVID HALPERN, Univ of Alabama - Tuscaloosa, HIDEKI FUJIOKA, JASON RYANS, DONALD GAVER, Tulane University — We developed a reduced dimensional model of the flow resistance by the motion of a viscous plug through a liquid lined tube.This is motivated by our interest in developing large-scale models of interfacial flows in pulmonary networks. Unfortunately, full CFD calculations are not viable, so we propose a semi-empirical formula for the resistance as a function of plug length, capillary number (Ca) and precursor film thickness. We developed CFD-based empirical relationships for the resistance contributors (front and rear meniscus and the plug core). The front meniscus resistance varies with Ca and the precursor film thickness. The rear meniscus resistance increases monotonically with decreasing Ca. We use a Poiseuille model in the core region, so the resistance linearly increases with plug length. With this we estimate the max wall shear and normal stress and gradients. The results show that for fingers of air propagating through airways, the epithelial cell damage correlates with the pressure gradient. However, for shorter plugs the front meniscus may provide substantial stresses that could modulate this behavior and may influence cell injury.

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