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Spatial spread of defective interfering particles and its role in suppressing viral load

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Influenza A virus (IAV) is an RNA virus with 8 gene segments. Experimentally it has been observed that most virions are non-productive at low multiplicity of infection due to missing expressions of one or more segments of the genome. These virions are termed as semi-infectious particles (SIPs). We developed a spatial model to consider the within-host dynamics of productive IAVs (known as fully infectious particles or FIPs) and SIPs using partial differential equations. We analyze how the production of defective interfering particles (DIPs) impacts on the dynamics of FIPs and SIPs. We found that the solutions to the PDEs follow travelling wave behavior. We determined the conditions for the coexistence of FIPs, SIPs and DIPs, and found that increase in the DIPs production can substantially decrease the total viral load. Our results have implications for the rational design of antivirals based on DIPs for IAV infections as well as other acute infections where virus spreads in a spatial manner.