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Modeling the dynamics of Usutu virus infection in birds

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Usutu virus is a mosquito-borne flavivirus maintained in wild bird populations, causing high avian mortality rates and occasional severe neurological disorders in humans. It has been hypothesized that increased Usutu virus replication in birds and/or decreased bird immune competence leads to increased mosquitoes infection and increased spillover in humans. To provide insight into the intrinsic complexity of host-virus processes in birds, we use within–host mathematical models to characterize the mechanisms responsible for virus expansion and clearance in juvenile chickens challenged with four Usutu virus strains. Several virus strains are co-circulating in the wild, and we find heterogeneity between the virus strains, with the time between cell infection and viral production varying between 16 h and 23 h, the infected cell lifespan varying between 48 min and 9.5 h, and the basic reproductive number varying between 12.05 and 19.49. The strains with high basic reproductive number have short infected cell lifespan, indicative of immune responses. The virus strains with low basic reproductive number have lower viral peaks and longer lasting viremia, due to lower infection rates and high infected cell lifespan. These results can be used to better determine which virus strain is the most likely to spillover in the human population. We also investigate the effect of antibody on virus dynamics by fitting the models to chickens that were genetically engineered to have low and high antibody count; and show that the viral clearance rate is a stronger mitigating factor for USUV viremia than neutralizing antibody response in this avian model.