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Evidence for history-dependence of influenza pandemic emergence

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Influenza A viruses have caused a number of global pandemics, the most recent being the H1N1 pandemic in 2009, resulting in considerable human mortality. Despite influenza pandemics being rare events, with it currently being nearly impossible to predict the next influenza emergence event, it may be the case that the virus itself provides us with outbreak signals that should prompt us to be more prepared. Specifically, knowing whether or not influenza pandemic occurrences are uniformly random in time can inform the intervention strategies that would be best suited to reduce the risk of further pandemic events.

To determine whether the emergence of new pandemic strains is a memoryless or history-dependent process, we analyse the time periods between influenza pandemics since 1700 statistically under different modelling assumptions. Using Bayesian model selection between exponential and gamma distributions for these time periods, we demonstrate from these small but informative datasets support for the hypothesis of history dependence under eight out of nine sets of modelling assumptions. Using the fitted parameters to make predictions shows a high level of variability in the modelled number of pandemics from 2010–2110.

Though the approach we take relies on limited data, so is uncertain, it provides cheap, safe and direct evidence relating to pandemic emergence, a field where indirect measurements are often made at great risk and cost. Our findings supporting the presence of history dependence enhances the motivation for implementation of active surveillance at the human-animal interface, in particular to elucidate the biological processes behind the observed spacing between pandemics.

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