

## Weakly Transmissible Diseases

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The standard theory of deterministic models for infectious diseases provides a good understanding for infections where the basic reproduction ratio ( $R_0$ ) is either much smaller or much larger than one. However, when the basic reproductive ratio is close to one, then stochastic effects dominate and concepts from branching processes become most useful.

Recently work by House using branching process/networks applied to Ebola [1] has demonstrated the power of this concept which has potential use in other diseases. Put more simply given a single introduction of disease and assuming offspring distribution belongs to a certain family one can consider the final size of an outbreak. Basic analysis assumes a Poisson distribution on the offspring and then extends this to a Negative Binomial distribution. This project can extend the theoretical limits of this area (based on draft notes and code provided by the co-supervisors) to allow for zero-inflation (a concept well used in regression analysis [2], which assumes that zeros in the data can be attributed to particular reasons external to the main dynamics. If these zero observations do not cause further cases themselves then a different variance structure will be observed over simply considering under-reporting alone.

An alternative setting may be to consider the total number of unique contacts made by a case and assuming the probability of infection at each contact changes. A simple model for this would then arise from a beta-binomial distribution (where the beta distribution models susceptibility of contacts, infectiousness of case etc.) this project can work on the similarities and differences between the binomial and Poisson motivated distributions.

The papers [3,4] contain possible outbreaks for Plague and Flu respectively that might enable limited testing of the models to prove principles as should the FF100 data collected during the 2009 pandemic. Parameter estimates may be compared with contact survey data.

This work could easily be extended in multiple directions for a PhD, either by considering other data sources, by focusing on novel theoretical elements, by considering the impact of finite population size or by developing techniques for infections near their eradication threshold.

1. <http://elifesciences.org/content/3/e03908>
2. [http://espace.library.uq.edu.au/eserv.php?pid=UQ:9053&dsID=tm\\_ele\\_8\\_05.pdf](http://espace.library.uq.edu.au/eserv.php?pid=UQ:9053&dsID=tm_ele_8_05.pdf)
3. <http://www.tbiomed.com/content/7/1/39>
4. <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3857146/>

Joe Hilton has already indicated his interest in pursuing this project.