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Modeling indirect transmission of *Campylobacter* in broilers

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Introduction

During the last major epidemics of CSF, FMD and AI in The Netherlands for 80-90% of all cases the route of transmission remained untraced. Indirect transmission should account for a large part of this untraced transmission. Better insights into the underlying mechanisms of indirect transmission are necessary for the development of new or improved bio-security measures.

Aim of this research

Gain more insight in the underlying mechanisms of indirect transmission with the aid of both experimental data and mathematical modeling.

Methods

- Experiments with *Campylobacter* in broilers are used as a model system for indirect transmission
- Development of a mathematical model for indirect transmission, testing whether this model can fit experimental data with biologically plausible parameter values.

Experimental setup

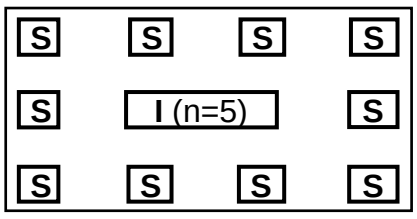


Figure 1. *Schematic overview of the housing of the experimental groups. (S is susceptible animal, I is infectious animals). Distance between I- and S-animals is 75 cm.*

- Four groups, daily swabbed, S-animal infected => removed from experiment

Model setup

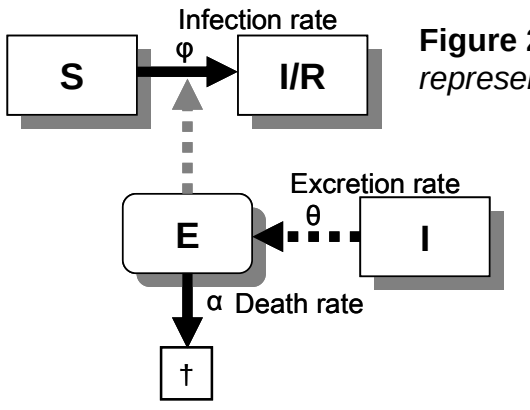


Figure 2. *Schematic representation of the model*

Mathematical representation:

$$\frac{dS}{dt} = -\varphi ES$$

$$\frac{dE}{dt} = \theta I - \alpha E$$

Why this model?

Data of the experiments show a significant trend in timing of infections. Instead of a constant infection pressure over time a gradual buildup of the infection pressure in time is assumed.

The environmental reservoir is filled by excretion of pathogen in the course of time (with rate θ), and partly emptied because of death of pathogen (rate α), thereby creating a gradual buildup of pathogen.

Results

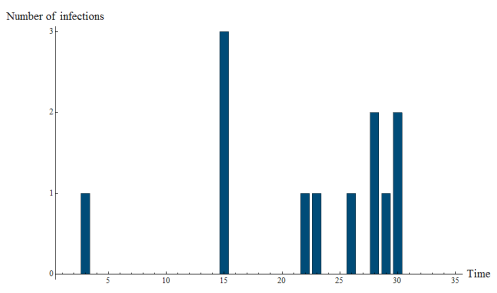
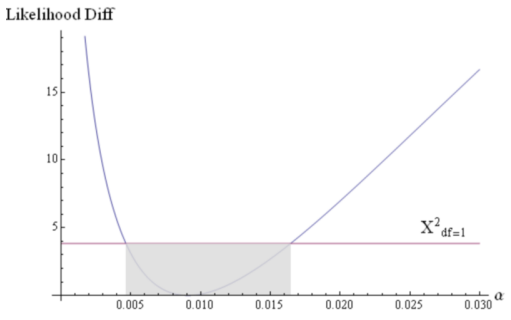


Figure 3. *Time points of infections*

Data from the experiments show significant trend in timing of infection, more infections toward the end of the experiment (X^2-test, p=0.0087).



Maximum likelihood estimation for α yields α = 0.009 (survival time: ± 100 days),
95% CI: [0.0046;0.016].
However, literature estimation for α is 0.5 (survival time 2 days).

Figure 4. *Confidence interval construction for α*

Based on parameter estimation and literature values for the death rate this specific model is falsified.
New models could include pathogen heterogeneity to account for different values of death rate.

Conclusions

- Significant trend in timing of infection.
- SIR-model extended with environmental reservoir needs biologically implausible parameter values thereby falsifying this specific model.

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