Simulation of outbreaks of highly contagious diseases using InterSpread Plus: sensitivity analysis of input parameters

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Key words
Simulation, InterSpread Plus, Foot-and-mouth disease, Design of experiment, Sensitivity analysis

Aim of the study
Simulation software can be a useful tool for the elaboration of contingency plans. The aim of this study was to decide whether InterSpread Plus would be applied as such a tool in Switzerland or not in order to work out strategies against Foot-and-mouth disease.

Material and methods
We used the same dataset as Iris Bachmann did in her doctoral thesis 2004 („Assessing effectiveness of control strategies against foot and mouth disease in Switzerland using a dynamic simulation model"). We selected 13 input factors and adapted them for our purposes, i.e. we determined a minimum and a maximum value for each of them.

The data was entered into the simulation model InterSpread Plus (Monte Carlo technique), the same software as used Iris Bachmann in her doctoral thesis, whereas we applied version 1.0.48.9.

As defined per fractional factorial design as the design of experiment we ran 64 scenarios with 20 iterations each and limited to 200 days per iteration to study main effects (factors) as well as interactions between them.

The sensitivity analysis of the total dataset of 1280 iterations was performed as follows: logistic and Poisson regression of the first outcome-variable number of infected premises IP, logistic and Cox regression of the second outcome-variable duration of the epidemics in days TP, respectively.

Results and significance
The factor defining the start of the infectivity of a farm had the biggest impact on the two outcome-variables IP and TP. In logistic models this factor alone explained 86 to 93% of the total variance. In scenarios where a farm was assumed to be infective from the time of its infection, the outbreak was much more likely to run out of control compared to scenarios where infectivity started with the appearance of clinical signs.

Since InterSpread Plus is strongly dependent on only one factor, we do not recommend this software to be applied as a tool in elaborating contingency plans for Switzerland.

Publications, posters and presentations
Publication: work in progress (to be submitted to Preventive Veterinary Medicine)
Reist, M. (2009) Use of fractional factorial design for the sensitivity analysis of a Foot-and-Mouth-Disease-model. Poster at SVEPM London UK April 2009.
Feyer, D. (2008) Sensitivity analysis of inputs for the disease spread model "InterspreadPlus" using foot and mouth disease as model disease. Presentation at CAVEPM Charlottetown CAN May 2008.
Schwermer, HP. (2009) Simulations of Foot-and-Mouth-Disease epidemics – sensitivity analysis of input parameters. Poster at ISVEE 2009.

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