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# Modelling the foodborne transmission mechanisms for norovirus

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## Background

Norovirus is one of the major sources of Infectious Intestinal Disease (IID) in the UK with about 2.8 million estimated cases in 2009. Like many enteric viruses, there are a number of different routes of infection that are thought to be significant in the spread of norovirus, which is easily passed from person to person. Other routes include contaminated foods, such as shellfish and fresh produce and infected food handlers.

The relative importance of these different routes for norovirus transmission is not well understood, nor is the way in which they interact with each other. This makes it difficult to target efforts on developing effective interventions that will reduce the number of cases. In particular, the relative importance of infection from contaminated food is uncertain, particularly given the frequent occurrence of transmission from person to person. Understanding this will help inform whether interventions directed at the food chain are likely to have significant impacts on reducing overall numbers of cases of norovirus.

## Research Approach

This study aimed to develop an initial system dynamics model to help inform our strategy in tackling norovirus by:

- developing a better understanding of the relative contributions of the food-related routes of transmission of norovirus
- assessing whether reducing risks in the food chain will have a material effect on the number of human cases, given the high level of person to person spread
- identifying gaps where further research may be required

The main routes of transmission included in the model are person to person, infected food handlers, bivalve shellfish and produce such as berry fruit and leafy vegetables.

The project followed six main stages:

- interviews with a number of norovirus experts to conceptualise the model and obtain an initial understanding of parameter values.
- creation of a first-cut model based on information gathered in the interviews.
- additional expert consultations, as necessary, to obtain further parameter values.

- completion of model formulation and parameterisation.
- model analysis - extraction of indicative findings on relative importance that food plays in norovirus transmission; identification of gaps in knowledge about parameter values; recommendations for further work.
- creation of a report on modelling work and summary presentation of study.

The model has been transferred to the our Operational Research Unit for further in-house development as necessary.

# Results

The study has developed a system dynamics simulation model which improves our understanding of the foodborne transmission mechanisms, gives further insight into the relative importance of foodborne transmission and indicates where our organisation might target its efforts to reduce foodborne transmission. The work evolved into two parts.

Part I involved the construction of a system dynamics model. A multi-agency expert team was consulted and discussed the model at a workshop. The model drew on existing person to person work but replaced an exogenous ‘forcing term’ for foodborne transmission with a set of internalised (endogenised) mechanisms. The effects modelled were:

1. contamination of bivalve shellfish via sewage
2. contamination of soft berry fruits and leafy vegetables via the use of sludge as a fertiliser
3. via infectious harvesters
4. via infectious food processers
5. via infectious food preparers in home and catering settings
6. contamination of other foodstuffs via infectious food preparers in home and catering settings

The conclusion was that it was indeed possible to disaggregate the foodborne routes as plausible causal mechanisms and that the modelling was useful to improve understanding of the mechanisms. The detail of the model, in the case of unknown parameter values, can be used to create an agenda for future research.

Part II employed an extended person-to-person model, re-calibrated using new data, to simulate changes in overall numbers of cases based on changes in either the foodborne or person-to-person transmission rates. This found that:

- although foodborne infections are estimated as only 2.5% of all norovirus infections, a doubling of this number could increase overall infections rising by one third. Conversely reducing them by half produces a 25% reduction in total incidence. Removing all foodborne cases produces a 75% reduction in norovirus, cases falling to 750,000 annually
- however, this must be seen in the context of the model’s much greater sensitivity to the person to person behaviour effects. Increasing these effects only 10% triples the incidence rate, while a decrease of only 25% causes incidence to collapse to about 10% of its current value. This high sensitivity indicates that:
- the observed large variation in norovirus incidence over time may be explicable in terms of small changes in human behaviour
- for any future actions, norovirus should be considered in a holistic way, the benefits of targeting person-to-person effects being judged on the same basis as the benefits for reducing foodborne effects. The modelling can therefore be used as a prioritising framework for discussions on interventions.

Both parts of the study were considered and eight detailed recommendations were made.

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