Bayesian Approaches in Microbial Risk Assessment

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Quantitative Microbial Risk Assessment (MRA) uses models to describe real-world systems (e.g. the passage of a given pathogen through a certain food production chain). MRA is used to determine foodborne disease-related human health priorities, and hence by decision makers to inform policy. MRA models can be large and complex, and involve parameters and processes which are uncertain in nature. It is recognised that, where possible, uncertainty and variability in MRA models should be separated: it is important to understand the contribution of uncertainty in model inputs to overall output uncertainty. Uncertainty and variability are, however, frequently incorporated arbitrarily in MRA models, rather than via formal probabilistic approaches. In addition, published applications of Bayesian methodology in MRA have generally, though not exclusively, emphasised input parameter uncertainty, rather than wider contexts.

Bayesian statistics presents a unified approach to uncertainty. Uncertainty is described by probabilities, and the opportunity to strengthen inference via the combination of prior belief and data is offered. This renders the Bayesian framework highly attractive for MRA. The opportunity to include prior information in analysis is an important strength in an MRA context; data can be sparse and Bayesian statistics, via the use of formal elicitation techniques, offers rigorous approaches to the incorporation of prior belief and associated uncertainty. Furthermore, recent methodological developments (BACCO [1, 2]) offer the opportunity, to carry out, for example, rapid sensitivity and uncertainty analysis for complex models: such analyses are typically infeasible using more traditional Monte Carlo methods.

The BAMRA working group is established under the NERC Environment and Human Health initiative, and brings together experts in risk assessment, Bayesian statistics, public health and food safety to review and further develop Bayesian statistical approaches in MRA. We present two typical BAMRA case studies from the setting of a model quantifying the risk from Vero-cytotoxigenic *E. coli* (VTEC) O157 in milk sold as pasteurised: a Bayesian sensitivity analysis of a model for the transmission of VTEC O157 around a dairy herd [3]; and an elicitation of expert opinion concerning, given a pasteurisation breakdown, the probability of this having occurred as a result of a pasteurisation failure, or as a result of post-pasteurisation contamination.

References

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