QUANTITATIVE RISK MODEL: *CAMPYLOBACTER* SPP. IN THE POULTRY FOOD CHAIN

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SUMMARY

This report describes the development of a quantitative risk model to investigate *Campylobacter* spp. contamination in the processing and consumption stages of the New Zealand poultry food chain. It covers work during the period 2003-2006.

The output of the model is intended to describe the exposure of New Zealand consumers to *Campylobacter* from poultry, in terms of probability that an exposure (e.g. a poultry meal) will be contaminated, and if so, the numbers of bacteria involved. The purpose of the model is to assess the effect of changes in the poultry food chain on that exposure. This is intended to support the development of risk management measures by the New Zealand Food Safety Authority.

The model describes each step in the chain in terms of the probability of a carcass or food serving being contaminated with *Campylobacter* and the numbers of bacteria present. Within a risk assessment, the model output (exposure) can be applied to dose response information to provide a risk characterisation that predicts the numbers of infected (or ill) people. However, there is considerable uncertainty in this prediction for a number of reasons. This step has been included in the current model, but with appropriate caveats.

The model itself consists of a computer file written using the @RISK software. The model simulates the production of a hypothetical representative New Zealand primary processing plant on a single day. The output from the plant is taken to be representative of the large majority of the poultry supply in New Zealand. The model then uses the characteristics of that poultry production in terms of prevalence and numbers of *Campylobacter* on carcasses, to simulate various consumption channels. Finally the numbers of positive exposures and numbers of cells involved in those exposures are combined with estimates of the frequency of various consumption events in New Zealand to predict numbers of human infections and illnesses on a daily basis.

Processing includes primary processing (from entry to the slaughter house to after the immersion chiller) and secondary processing (portioning, storage, distribution) up to purchase by the domestic consumer or foodservice sector. The model examines the effect on the prevalence and numbers of bacteria through the primary processing steps, including cross contamination at the defeathering stage. The carcasses are then directed into one of two channels: domestic, and foodservice. The foodservice channel is then further split into three: fast food outlets, restaurants, and "other".

In each of these channels, the probability of contamination and numbers of bacteria in four potential human exposures are considered: contamination of the exterior of packaging encountered during food purchase, cross contamination to hands during food preparation, cross contamination to a secondary food during food preparation, and undercooking.

Outputs from the model indicate that during primary and secondary processing cross contamination causes a marginal increase in the prevalence of contaminated carcasses above that caused by contamination of birds from infected flocks. Cross contamination from residual bacteria on machinery etc., is considered to affect only a small number of uncontaminated carcasses and the model has been constructed to reflect that.

The number of bacteria on contaminated carcasses immediately after the spin chiller has a predicted mean of 2.871 $\log_{10}$ cfu (743 cells). This represents a considerable decrease in numbers from the mean of 6.71 $\log_{10}$ cfu on contaminated birds at entry to processing.

The number of positive exposures is predicted to be heavily weighted to the domestic channel (approximately 90%) over the foodservice channel. The probability of infection is greatest for ingestion of cells resulting from cross contamination of another food, followed by contamination of hands during food preparation. Ingestion of cells from contamination of hands from packaging, or survival of cells through undercooking, represents only small contributions to the overall probability of infection.

The model outputs appear reasonable in terms of the numbers of bacteria on a carcass. The available data indicate a prevalence of infected flocks in New Zealand of 34%, from which the model predicts a lower prevalence of contamination in the fresh poultry supply (34%) than has been observed from retail survey data (50-60% of whole carcasses contaminated). One possible reason for this is that cross contamination during secondary processing is underestimated; the potential for cross contamination during handling in supermarkets has not been explicitly included. Alternatively the actual prevalence of infected flocks may be higher.

The model predicts the number of new illnesses based on the estimated number of daily potential exposure events. This translates into a yearly number of new cases of campylobacteriosis (approximately 57,000 ill people) which is a significant proportion of the estimates based on surveillance data (approximately 14,000 notified cases per year, perhaps 100,000 cases in the community as a whole), and suggests that poultry exposures are a significant cause of infection and illness from *Campylobacter*.

The estimated probability of infection from the dose response Beta–Poisson model mostly involves exposures of low cell numbers. The Beta-Poisson model has a large uncertainty at these low values and so these estimates need to be treated with caution.

Preliminary investigation of changes in model parameters representing potential risk management strategies suggest that reductions in predicted numbers of infected or ill people are greatest for reductions in flock prevalence, freezing of the poultry supply, or primary processing interventions to reduce the numbers of bacteria on carcasses. Logistic slaughter, reducing the numbers of bacteria on birds at entry to processing, changes in cross contamination during primary processing, and alterations in the reduction of bacteria through undercooking cause only minor changes in predicted cases. Selection of the most effective risk management strategy will require both consideration of model predictions in terms of public health, as well as economic and technological considerations.