A QUANTITATIVE RISK ASSESSMENT FOR CAMPYLOBACTER IN CHICKENS

Hartnett E[1], Kelly L[1], Newell D[1], Wooldridge M[1], Gettinby G[2]

[1] Veterinary Laboratories Agency, Addlestone, Surrey KT15 3NB, UK
[2] Department of Statistics and Modelling Science, University of Strathclyde, 26 Richmond Street, Glasgow, G1 1XH, UK

Campylobacter jejuni and *C. coli* are the commonest cause of human acute gastro-enteritis world-wide. In England and Wales during the period 1988 to 1998 the numbers of reported cases increased from 28 thousand to 58 thousand. This is a gross underestimate as many cases go unreported[1]. Infection with campylobacters has been epidemiologically linked with the consumption of under-cooked chicken meat[2] and as a result several epidemiological studies have been aimed at evaluating methods for preventing the colonisation of poultry with this organism[3]. However, the level of contamination of chicken products at point of ingestion is a result of effects at all other stages in the chicken supply chain; therefore an investigatory process involving all stages of the supply chain is required to identify critical control points and hence facilitate the design of effective prevention and control strategies. To this aim a quantitative risk assessment (QRA) model is currently being formulated to investigate the risk of human infection with campylobacter from the consumption of chicken meat/products in Great Britain (GB). This paper considers the development of the exposure assessment for campylobacter in chicken. That is the probability that a random individual ingests campylobacter as a result of a contaminated chicken product, along with the probable number of organisms ingested.

Materials and Methods

The QRA model framework is illustrated in Figure (1).

Figure (1): Model Framework

The modules illustrated in Figure 1 correspond to the fundamental steps of any risk assessment as described by Covello & Merkhofer[5].

In accordance with Covello & Merkhofer[5] the risk assessment begins by considering the probability that campylobacters will be present in retail chicken. This is achieved through the first and second modules shown in Figure (1), 'Rearing and Transport' and 'Slaughter and Processing'. The first module, 'Rearing and Transport', estimates the probability that a random bird from the GB poultry flock will be campylobacter positive at the point of slaughter. The colonisation of chicken flocks with

campylobacter is well documented and it has been reported that once a flock has been exposed to campylobacter the percentage of birds colonised will reach 100% within seven days[6]. The probability that a random bird selected at the point of slaughter from the GB flock is campylobacter positive is defined as P_{pb} and is estimated from equation (1).

$$P_{pb} = P_{pf} P_{wfp} \qquad (1)$$

Here P_{fp} is the probability that a flock is positive at slaughter, and P_{wfp} is the probable within-flock prevalence of a flock at slaughter. P_{fp} is estimated using available data including industrial surveys and an epidemiological study[3]. Estimation of P_{wfp} is achieved by the use of a mathematical model describing the horizontal transmission within a flock from the time of exposure until depopulation. More specifically this model consists of a modified chain binomial model and a differential equation model, which describes epidemic spread.

Following on from this the probability that a retail chicken product will be contaminated and the probable level of contamination is estimated within module 2, 'Slaughter and Processing'. The processing of chicken meat consists of a highly controlled system of events. Beginning with the slaughtering process through to transport of the final sale product welfare of live birds and then carcass quality are top priorities. These two factors govern the way in which processing procedures are carried out. Any pathogens which form part of the faecal microflora have the potential to contaminate carcasses during slaughter and processing. The extent of this will depend on the prevalence of the organism in the birds as well as the hygienic standards employed during processing. By using available information on common processing practices employed by the GB broiler industry the model follows a carcass through the processing facility. The model simulates the selection of a bird from the national flock along with a history determined by the outputs from 'Rearing and Transport'. More specifically the bird is assigned a positive or negative campylobacter status, a flock status, a level of external contamination and an internal microbial load as appropriate. The model then examines the effect of each of the processing stages on the campylobacter contamination levels of the carcass. The result is an estimation of the probability that a random chicken product will be contaminated with campylobacter and the probable level of contamination.

Once the probability of the occurrence of a contaminated chicken product being presented for sale has been estimated it is necessary to determine the resulting levels of exposure to campylobacter within the GB population. Infection with campylobacter has been linked to the inadequate cooking of chicken[2] and the cross-contamination of organisms to ready-to-eat products. It is therefore appropriate to follow a random product through stages from the point of purchase up to consumption of campylobacter contaminating the product. This forms the third module of the QRA, 'Preparation and consumption'. Here a random product with a level of campylobacter contamination determined from 'Slaughter & processing' is followed through preparation up to consumption by considering preparation methods, cooking times and temperatures and

levels of cross-contamination for a random individual, and examining any effects on the contamination levels present.

Results

Results from modules 1 and 2, 'Rearing & Transport' and 'Slaughter & Processing' based upon 10,000 iterations using Monte-Carlo simulation and Latin Hypercube sampling suggest that the most likely probability that a random bird selected at slaughter from the GB flock is campylobacter positive is 0.69, with a 95^{th} percentile of 0.72. However preliminary results based on a carcass prepared for fresh whole sale suggest that following processing the most likely probability that a carcass is contaminated with campylobacter is in the region of 0.90. This increase can be attributed to cross contamination during the processing stages. These results are preliminary and require validating against retail surveys. The results presented here, along with estimates of the levels of contamination will be used within the third module as described above. This will provide an estimate of the probability that a random individual ingests campylobacter as a result of a contaminated chicken product, along with the probable number of organisms ingested.

Reference

1.Tompkins DS, Hudson MJ, Smith HR, Eglin RP, Wheeler JG, Brett MM, Owen RJ, Brazier JS, Cumberland P, King V, *et al*. A study of infectious intestinal disease in England: microbiological findings in cases and controls. Communicable Disease and Public Health 1999;2(2):108.

2.Harris NV, Weiss NS, Nolan CM. The role of poultry and meats in the aetiology of *Campylobacter jejuna/coli* enteritis. American Journal of Public Health 1986;76(4):407-11.

3.Evans S. A longitudinal study of thermophillic campylobacter infection of poultry broiler flocks in GB. Report for Animal Health Veterinary Group, MAFF, Tolworth 1996.

4.Covello, Vincent T.; Merkhofer, Miley W. Risk assessment methods: approaches for assessing health and environmental risks. New York: Plenum press; 1993.

5.Shanker S, Lee A, Sorrell TC. Horizontal transmission of *Campylobacter jejuni* amongst broiler chicks: experimental studies. Epidemiology and Infection 1990;104:101-10.

6. Medema GJ, Teunis PFM, Havelaar AH, Haas C. Assessment of the dose-response relationship of *Campylobacter jejuni*. International Journal of Food Microbiology 1996;30:101-11.