An ecological approach to environmental sources of campylobacteriosis in New Zealand

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Abstract Only

Presented at the 10th Colloquium of the Spatial Information Research Centre, University of Otago, New Zealand, 16-19 November, 1998

The rate of campylobacteriosis in New Zealand is now over 200 cases per 100,000 per year (CDC, 1997), making this the most common of our notifiable diseases. Campylobacteriosis occurs more than twice as commonly here as in England, and more than three times as commonly as in Australia and Canada (CDC, 1993). This differential between countries is also clearer for Campylobacteriosis than for other notified foodborne illnesses (Malcolm, 1994).

The direct cost of Campylobacteriosis to the New Zealand community is estimated to be $4.48 million per annum with true costs possibly in the order of $40 million per annum (Withington and Chambers 1996), when underreporting is considered (Hudson, 1997).

Recent epidemiological studies have focused on the modes of transmission of Campylobacter in New Zealand. The consumption of raw or undercooked chicken (Eberhart-Phillips et al. 1997, Ikram et al 1994) and contaminated drinking water (Brieseman, 1987; Stehr-Green et al, 1991, Bohmer, 1997) are known to be risk factors for infection. However acting on these risk factors may have limited effectiveness if interventions are focused solely on reducing human exposure without consideration of the environmental reservoirs of the bacteria.

A more effective approach may be to reduce the frequency with which the organism contaminates food and water, thereby reducing the human exposure. Primary prevention of this kind requires a detailed knowledge of the ecology of the disease, including consideration of the natural and occupational environment, animal reservoirs, and human hosts.

An ecological approach of this kind can lead to recommendations for public health interventions that are not otherwise obvious. For example, when applied to the mosquito borne disease Ross River virus in Australia, this approach has led to a fundamental change in the recommendations for vector control (Weinstein, 1997).

There are good grounds to believe that climatic and agricultural factors are important influences on the prevalence of the organism in the New Zealand environment (Bohmer 1996; Weir,1998). In NZ, outbreaks of campylobacteriosis which were linked to the water supply have followed heavy rain, and are likely to be related to nearby grazing animals (Brieseman, 1987; Stehr-Green et al, 1991). Overseas the importance of extreme rainfall events for waterborne gastroenteritis (Patz et al 1996) has also been demonstrated in study of Campylobacters in a river system (Bolton et al 1987), and cryptosporidiosis (Brazil, 1994), which also has widespread animal reservoirs and potential for water transmission.

There is some evidence of a relationship between agricultural practices and gastroenteritis in New Zealand. For example, a case control study that is now underway has found that over half of the cryptosporidiosis notifications during the lambing season were associated with direct animal contact (Russell, 1998). Others have suggested that horizontal transmission from the environment was the most likely route for infection of new flocks with Campylobacter in a closely controlled poultry farm (Jacobs Reitsma et al, 1995).

New Zealand provides a unique opportunity to study interactions between climate and agriculture because of its (1) widespread and regionally varied agriculture (with about 50% of the country in pastoral use, compared to a world average of 25%) and high livestock densities (with over 12 times the density of sheep and three times the density of cattle relative to the world average) (Taylor & Smith, 1997); (2) regionally and seasonally variable rainfall (from 400 to 11,000mm (VUW 199?)); (3) a latitudinal spread of temperatures, which also affect agricultural practices (e.g. different regional lambing seasons); and (4) a wide variety of drinking water supplies and qualities of water catchment.

The present project will capitalise on this natural experimental design and on our high notification rates of campylobacteriosis to investigate, for the first time, the relative contribution of various agricultural and climatological factors to the disease burden. With a novel ecosystem approach and a unique range of study environments, New Zealand has the opportunity to make significant new contributions to the understanding of campylobacteriosis both here and internationally

Research Design

The project will consist of two stages. The first is the calculation of regional rates for Campylobacter notification, and the second is the attempt to explain any differences in the regional Campylobacter notifications using climate, agriculture and water catchment as explanatory variables.

Information about campylobacter infections will be obtained from the Communicable Disease Centre for all notified cases between 1 July 1994 to 30 June 1998. This will involve around 35,000 cases. Information about each case will include a mesh block identifier which has been geocoded using the home address, date of onset, age, sex, ethnicity, and whether it is part of a known outbreak (as defined in the Magic Study) (Eberhart-Phillips et al et al 1997). No one will be able to identify individuals using this data.

This information will be stratified into: 1) all cases, 2) those arising from known outbreaks and 3) those which are believed to be non-outbreak. Cases will be modeled in a GIS environment assigning each case to the relevant mesh block. The spatial patterns will then be described using Incidence Ratios standardised for age, sex and ethnicity, using the NZ national population from the 1996 Census.

Two climate variables, monthly rainfall total and monthly 48 hour maximum rain extremes, will be modeled by NIWA. NIWA hold New Zealand Meteorological records and have expertise in both interpreting and modeling weather patterns. Climate surfaces will be produced as an Arc Grid data set, with two raster surfaces over 60 monthly data points during the five year period.

This data set will be integrated with data sets for climate, agriculture, water catchment and case data layers at the Spatial Information Research Centre, University of Otago, using interpolation methods (aerial variant method) on a GIS model. Each mesh block will also be coded according to its socio-economic status (Deprivation Index, 1996, Wellington School of Medicine).

Agricultural data will be obtained from the Statistics NZ Agricultural survey in 1994, and the sample surveys in 1995 and 1996. This will describe for each of the 74 territorial authorities: numbers, and locations of, sheep, dairy cattle, beef cattle, hens and pigs, the type of farming which represents the principal economic activity of that territorial authority (e.g. sheep with beef) and when the main calving and lambing seasons occur.

Water catchment data is being modeled using GIS in a Wellington School of Medicine - Ministry of Health collaborative study of waterborne protozoa. These existing GIS surfaces will be used to define the principal water catchment area and its corresponding water distribution areas which will be described as primarily urban or rural. Each area will be graded according to the percentage of time that they transgress the national water standards (WINZ database, Ministry of Health).

The level of association between potential exposure factors (climate, agriculture and water catchment area) and the outcome factor (Campylobacter notification) will be analysed using multiple regression. An estimate of the proportional contribution of each key variable to the campylobacteriosis disease burden will thus be obtained.

The results of this analysis will help to achieve a better understanding of the role that factors which may influence the environmental reservoirs play in the prevalence of campylobacter and the study may therefore point to potentially novel interventions which aim to reduce the frequency with which the organism contaminates food and water, thereby reducing the hazard rather than focusing on decreasing exposure..

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