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Molecular epidemiological studies of *Campylobacter* isolated from different sources in New Zealand between 2005 and 2015

A thesis presented in partial fulfilment of the requirements for the degree of

Doctor of Philosophy

at Massey University, Manawatu,

New Zealand.

Antoine Nohra

May 2017
Abstract

Campylobacteriosis is one of the most important food-borne diseases worldwide, and a significant health burden in New Zealand. *C. jejuni* is the predominant species worldwide, accounting for approximately 90% of human cases, followed by *C. coli*.

The first study evaluated whether the time elapsing from sampling to culture has an impact on the recovery rate of *Campylobacter*, and explored whether some sequence types are more likely than others to be missed due to delayed culture. The study revealed that, whereas delayed culture may affect the recovery rate of *Campylobacter*, there was no evidence of a bias due to specific sequence types being under detected.

The second study aimed to analyse the differences in the *Campylobacter* viable counts and in population genetic structure between chicken drumsticks and whole carcass meat for retail sale. The results indicate that the *Campylobacter* population genetic structure did not differ between the two types of retail chicken meat. However, the difference in *Campylobacter* viable counts suggest that consumption of different chicken meat products may pose different risks of campylobacteriosis associated with an exposure to different infection doses.

In the third study, we genotyped *C. coli* isolates collected from different sources between 2005 and 2014, to study their population structure and estimate the contribution of each source to the burden of human *C. coli* disease. Modelling indicated ruminants and poultry as the main sources of *C. coli* infection.

The fourth study aimed to genotype *C. jejuni* isolates collected between 2005 and 2015 from different sources, to assess changes in the molecular epidemiology of *C. jejuni* following the food safety interventions implemented by the New Zealand poultry industry in 2007/2008. Modelling indicated that chicken meat from ‘Supplier A’ was
the main source of *C. jejuni* human infection before the interventions; but after the interventions, ruminants became the main source of infection, followed by chicken meat from Supplier A.

This thesis has made us aware of the aetiology of *C. coli* infections and the change in the attribution of *C. jejuni* infections. These findings should be used in developing further strategies to reduce the total burden of human campylobacteriosis.
Acknowledgement

I would like to take this opportunity to thank God for all His blessings that He has given me during my time of study. Studying in New Zealand was one of the most memorable experiences in my life. I would like to thank both the New Zealand government for granting me the visa and the New Zealand people for their hospitality and kindness, helping me feel comfortable and welcome in making my studies more pleasant, less stressed and at ease.

Academically speaking, I would like to thank my primary supervisor Dr Alex Grinberg who taught me many things during these years. Thank you for your precious time, effort and the support you showed me during my study period. Thank you for your kindness and encouragement during some difficult times.

I was privileged to have a panel of kind co-supervisors who provided mentorship and shared their knowledge to complete my thesis. I would like to start off by thanking Prof Nigel French for your time and commitment which led me to focus and continue on with my studies in the right direction. Without your continuous support and expertise my experience would not have been the same. It was an honor to have the opportunity to work with you and learn from your wide library of knowledge. To Dr Julie Collins-Emerson, I would like to thank you for your research experience that you shared and for your valuable comments and your quick comments on my thesis chapters. To Dr Anne C. Midwinter, I appreciate all your support and care that you kindly disclosed to me through my time of study. Your patience, reassurance and attention while listening to my problems, giving me advice and encouragement made me feel inspired, less stressed and focused to continue on in my studies. Your valuable comments, immediate corrections and wisdom all played a great part to my thesis. Lynn Rogers and Rukhshana Akhter at “EpiLab, which I would also like to acknowledge for their
technical support and Dr Jonathan Marshall for his time and assistance in the statistical analysis. Moreover, I am grateful to the Institute of Veterinary, Animal and Biomedical Sciences for funding couple of research projects and conference travel. Thank you to the New Zealand Ministry of Primary Industry because the isolates examined in this study were collected as part of the campylobacteriosis surveillance program funded by them.

I would like to thank my parents extensively for their support throughout all my academic years. Coming to New Zealand from Lebanon without a scholarship would not have been accomplished without their love, financial help and support. To my father, Salim, I am very thankful for all your hard work and efforts that you have generously bestowed towards me especially at this point of time in your life. Your financial contribution allowed me to have a decent life and I am forever grateful. To my Mother, Maud, thank you for all the love, care, and sacrifices that you continually offered me, including the simple daily skype calls with you that gave me determination to keep moving forward. Thank you to both my sisters, Zeina and Samar, for their enthusiasm, support, and praise, always being there for me when I needed them. To Diane, my best friend in Sydney, my life is brighter with you in it. I would like to thank you for your help in relieving the stress of loneliness through our daily talks and laughs. Last but not least, I would like to thank George my Godfather who is like a father figure, big brother and best friend to me. Thank you for all your love, advice, sacrifices and financial support that you provided me. I am therefore fortunate to have you in my life.

Finally, I would like to dedicate this thesis to my little nephews Michael, George and Charbel as well as my niece, Maud, who are growing up so quickly during my time away. Seeing your smile once every year powered me with energy and determination to finish my PhD.
List of presentation and publication


**Nomenclature**

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>BA</td>
<td>Blood agar</td>
</tr>
<tr>
<td>BB</td>
<td>Bolton Broth</td>
</tr>
<tr>
<td>BPW</td>
<td>Buffered peptone water</td>
</tr>
<tr>
<td>CC</td>
<td>Clonal complex</td>
</tr>
<tr>
<td>cfu</td>
<td>colony forming unit</td>
</tr>
<tr>
<td>CrI</td>
<td>Credible interval</td>
</tr>
<tr>
<td>DALY</td>
<td>Disability Adjusted Life Years</td>
</tr>
<tr>
<td>DNA</td>
<td>Deoxyribonucleic acid</td>
</tr>
<tr>
<td>ELISA</td>
<td>Enzyme-linked immunosorbent assay</td>
</tr>
<tr>
<td>ESR</td>
<td>Environmental Science and Research Ltd.</td>
</tr>
<tr>
<td>GBS</td>
<td>Guillain-Barré syndrome</td>
</tr>
<tr>
<td>HL</td>
<td>Heat-labile</td>
</tr>
<tr>
<td>HS</td>
<td>Heat-stable</td>
</tr>
<tr>
<td>IID</td>
<td>Infectious intestinal disease</td>
</tr>
<tr>
<td>IVABS</td>
<td>Institute of Veterinary, Animal and Biomedical Sciences</td>
</tr>
<tr>
<td>mCCDA</td>
<td>modified Cefoperazone Charcoal Deoxycholate agar</td>
</tr>
<tr>
<td>MCL</td>
<td>Maximum composite likelihood</td>
</tr>
<tr>
<td>&quot;&quot;EpiLab&quot;&quot;</td>
<td>Molecular Epidemiology and Public Health laboratory</td>
</tr>
<tr>
<td>ML</td>
<td>Maximum likelihood</td>
</tr>
<tr>
<td>MLST</td>
<td>Multi locus sequence typing</td>
</tr>
<tr>
<td>MU</td>
<td>Massey University</td>
</tr>
<tr>
<td>NMDS</td>
<td>Non-metric multidimensional scaling</td>
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<tr>
<td>PCR</td>
<td>Polymerase chain reaction</td>
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</table>
PERMANOVA  Permutational multivariate analysis of variance
PFGE    Pulsed field gel electrophoresis
PSI     Proportional similarity index
spp.    Species
ST      Sequence type
WHO     World Health Organisation
Thesis structure and format

This thesis is composed of six chapters covering a literature review, four research-based chapters and a final discussion. Raw data are presented in Appendices. Some repetition between chapters was inevitable due to the style of the thesis presentation, especially in the materials and methods sections. These repetitions allow each chapter to be read in isolation.

Chapter one

This chapter is a general overview covering the main concepts and overviewing the influential literature addressed in the thesis. It discusses the molecular epidemiological studies of human campylobacteriosis in New Zealand and other countries and summarises the studies done in this PhD projects.

Chapter two

This chapter compares direct versus delayed culture for *Campylobacter* in human faeces, titled: “Detection and recovery rate of *Campylobacter* from faecal swabs: Direct vs delayed culture”

Chapter three

This chapter compares two types of chicken retail meat (whole carcasses versus drumsticks) collected from different suppliers, titled: “Abundance and multilocus genotypes of *Campylobacter* species isolated from chicken drumsticks and whole carcasses obtained from different suppliers in the retail chain”.

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Chapter four

This chapter titled “Molecular epidemiology of Campylobacter coli isolated from different sources in New Zealand between 2005 and 2014” formed the basis of a paper published in Applied and Environmental Microbiology:


Chapter five

This chapter compares the source attribution of C. jejuni-associated campylobacteriosis cases before versus after intervention, titled: “Changes in the molecular epidemiology of Campylobacter jejuni following food safety interventions by the poultry industry”.

Chapter six

This chapter summarises and discusses the significance of the results of the previous studies.

Appendices: The raw data and supplementary materials of each chapter are presented in this study.

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