

Institution: University of Aberdeen

Unit of Assessment: 1 - Clinical Medicine

Title of case study: Campylobacteriosis: risk assessment and reducing infection in humans

1. Summary of the impact

In one of the world's largest molecular epidemiological studies of its kind, researchers at the University of Aberdeen identified retail chicken as the single largest source of *Campylobacter* food poisoning in Scotland. Informed by this research, a joint working group with membership from industry and government was created to identify and put into place interventions to reduce *Campylobacter* in chickens. In addition, the evidence from Aberdeen was used by the European Food Safety Authority and the New Zealand Food Safety Authority to develop their own integrated approaches to protect the public from this food poisoning pathogen.

Therefore this has resulted in impact relating to: health and welfare, commerce and public services and international policies.

2. Underpinning research

Campylobacter is the most common cause of food poisoning in the UK. Symptoms include diarrhoea, abdominal pain, fever and vomiting, and infection can prove fatal for very young children, the elderly and immunosuppressed individuals. The Food Standards Agency (FSA) says *Campylobacter* was estimated to be responsible for more than 460,000 cases of food poisoning in England and Wales in 2012, resulting in more than 22,000 hospitalisations and 110 deaths. *Campylobacter* accounts for a third of the cost of the burden of foodborne illness in England and Wales, estimated at more than £583 million in 2008, since when infection prevalence has increased by some 30%.

Since 2001, researchers at the University of Aberdeen have investigated sources of human campylobacteriosis food poisoning. This work has been led by Ken Forbes, Reader in the Department of Medical Microbiology (1989-present), Norval Strachan, Professor of Physics (1998-present) and Iain Ogden, Research Fellow (1996-2012). In conjunction with the Food Standards Agency, they have led a substantial research programme involving industrial collaborators and collaborators at Oxford and Glasgow Universities.

Campylobacter bacteria live commensally in the gastrointestinal tracts of a wide range of animals and birds and so initial research focussed on identifying the sources of *Campylobacter* infection in humans (2001-2009). This involved a combination of statistical data analysis, public surveys and laboratory work. In the Aberdeen laboratories, multi-locus sequence typing was used to characterise isolates recovered from samples allowing researchers to reliably type different *Campylobacter* strains. This multidisciplinary process established that *Campylobacter* infection in humans was linked with *Campylobacter* contaminated poultry [1,2] and that exposure can influence a person's subsequent susceptibility to infection [3].

This research also showed that, especially in a rural environment, non-poultry sources of infection (i.e. from ruminants or wild birds) are also important [4,5]. Furthermore, high resolution molecular epidemiology was able to link trends in human *Campylobacter* infection with the changes in the population structure of *Campylobacter* found in retail chicken [6]. Also, although virtually all campylobacteriosis cases are believed to be sporadic (not recognisably linked) this epidemiological research identified evidence of a common source of infection in one-sixth of cases, even across considerable distances. This suggests that the UK's extensive food distribution networks may be playing an important role in the dissemination of contaminated chicken.

3. References to the research

[1] Sheppard SK, Dallas JF, Strachan NJC, Macrae M, McCarthy ND, Falush D, Ogden ID, Maiden

Impact case study (REF3b)

MCJ, Forbes KJ. (2009). *Campylobacter* Genotyping to Determine the Source of Human Infection. *Clinical Infectious Diseases*, 48:1072-1078.

Definitive research that led to this impact. Cites=75 by Aug 2013

[2] Strachan NJC, Forbes KJ. (2010). The growing UK epidemic of human campylobacteriosis. *Lancet* 376:665-667.

Cites= 8 by Aug 2013

[3] Forbes KJ, Gormley JF, Dallas O, Labovitiadi M, Macrae RJ, Owen J, Richardson J, Strachan NJC, Cowden JM, Ogden ID, Mcguigan CC. (2009). *Campylobacter*: immunity and co-infection following a large outbreak in a farming community. *Journal of Clinical Microbiology* 47:111-116.

Human exposure to Campylobacter. Cites=16 by Aug 2013

[4] Rotariu O, Dallas JD, Ogden ID, Macrae M, Sheppard SK, Maiden MCJ, Gormley FJ, Forbes KJ, Strachan NJC. (2009). Spatiotemporal homogeneity of *Campylobacter* subtypes from cattle and sheep across NE and SW Scotland. *Applied and Environmental Microbiology* 75:6275-6281.

Non-poultry Campylobacter epidemiology. Cites=11 by Aug 2013

[5] Strachan NJC, Gormley FJ, Rotariu O, Ogden ID, Miller G, Dunn GM, Sheppard SK, Dallas JF, Reid TMS, Howie H, Maiden MCJ, Forbes KJ. (2009). Attribution of *Campylobacter* infections in northeast Scotland to specific sources using multi-locus sequence typing (MLST). *Journal of Infectious Diseases* 199:1205-1208.

Human Campylobacter epidemiology. Cites=36 by Aug 2013

[6] Gormley FJ, Macrae M, Forbes KJ, Ogden ID, Dallas JF, Strachan NJC. (2008). Has retail chicken played a role in the decline of human campylobacteriosis? *Applied and Environmental Microbiology* 74:383-390.

Campylobacter epidemiology in poultry and humans. Cites=48 by Aug 2013

Funding supporting the work:

[i] Pennington TH, Ogden ID, Forbes KJ (2001-02) "Identification of the source of the *Campylobacter* summer surge: an MLST study". £38,363 from Chief Scientist Office, Scotland.

[ii] PhD studentship (2001-2005) "Understanding the causes of human campylobacteriosis" £33,900 from the University of Aberdeen Faculty of Science and Engineering.

[iii] Cowden J, Smith-Palmer A, Strachan N, Ogden I (2005-08) "Collection and analysis of household water samples of participants from *Campylobacter* case control study". £172,143 from Food Standards Agency.

[iv] Forbes KJ, Ogden ID, Strachan N, Fenlon D, Maiden M (2005-2008) "The Molecular Epidemiology of Scottish *Campylobacter* Isolates from Human Cases of Infection using Multilocus Sequence Typing". £832,246 from Food Standards Agency.

[v] PhD studentship (2005- 2008) "Elucidating the epidemic fall of human campylobacteriosis". £39,000 from the University of Aberdeen plus £10,000 from Food Standards Agency.

[vi] Reid S, Innocent G, Strachan N, Rotariu O, Forbes KJ, Ogden ID (2006-2007) "Factors associated with geographic and temporal variation in campylobacteriosis in humans". £321,196 from Food Standards Agency.

[vii] PhD studentship (2008-2011) "Campylobacteriosis: Elucidating the Disease Burden, Risk Perception and Costs to Rural Communities and their Families". £55,000 from Rural Economy & Land Use programme Tied Studentship award, ESRC/BBSRC.

[viii] Forbes KJ, Ogden ID, Strachan N, Maiden M (2010-12 and 2013-15) "Employing Source Attribution and Molecular Epidemiology to measure the impact of interventions on human campylobacteriosis in Scotland". £297,236 and £754,875 from the Food Standards Agency.

4. Details of the impact

The Aberdeen report investigating the key sources of *Campylobacter* infection in Scotland was the first study in the world to do so on a national scale. It provided the Food Standards Agency (FSA)

Scotland with clear evidence that broiler chickens were the single most significant source of *Campylobacter* food poisoning [a,b]. The report was published by the FSA Scotland (2009) on its website [c], and the Aberdeen researchers were invited to present their findings at an FSA key stakeholder event held a month later which was attended by some 100 stakeholders in NHS microbiology and public health, public analysts, Defra, FSA, Health Protection Scotland (HPS), the National Farmers' Union (NFU), the then Scottish Agriculture College (SAC), the Scottish Food Advisory Committee (SFAC), and the Scottish Government Health Department.

As a direct result of the Aberdeen findings [c,d], the FSA recommended intervention strategies should be targeted to the broiler food chain, and the FSA's Strategy for 2010-2015 [e] and its Foodborne Disease Strategy (2010-2012) [e] were developed. The important role of contamination in undercooked chicken liver pate, eg [3], in many outbreaks has been identified in FSA health warnings.

One month after the FSA report was published, a Joint Working Group on *Campylobacter* (JWGC) was established as a joint industry and government initiative [f] with an aim to identify interventions that could reduce *Campylobacter* in chicken. Membership includes the British Poultry Council (BPC), the National Farmers' Union (NFU) the British Retail Consortium (BRC), the FSA and Defra. Drawing on the researchers' identification of the role the UK's food distribution network has played in the dissemination of contaminated chicken, an Action Plan with a strategy for overseeing on-farm, transport, processing, retail, consumer and catering sector trials and interventions, as well as surveillance and monitoring, was developed. An industry target to reduce *Campylobacter* in UK produced retail chicken from 27% to 10% by 2015 was set.

In terms of public health, the JWGC estimate that reaching their target of 10% reduction in *Campylobacter* loads in broilers by 2015 could mean a reduction in *Campylobacter* food poisoning of up to 30% - about 170,000 cases per year. In 2009, the Aberdeen team provided the European Food Safety Authority (EFSA) BIOHAZ panel with evidence of the extent to which meat derived from broiler chickens contributes to human campylobacteriosis. The panel recommended the establishment of active surveillance of campylobacteriosis in all member states – including a representative collection of isolates from humans and putative reservoirs in all member states for genotyping and storage [g,h]. Following on from their assessment the EFSA is expected to set maximum permitted *Campylobacter* loads in chicken within the EU next year.

During October 2009 a member of the Aberdeen research team work shadowed and presented at a workshop at the New Zealand Food Safety Authority on the use of molecular modelling techniques to identify different strains of *Campylobacter* in order to gain a better understanding of the sources of New Zealand's own epidemic and to support appropriate intervention strategies. Resulting interventions led to lower incidences of infection in New Zealand broiler chickens and reduced incidences of human campylobacteriosis and of Guillain–Barré syndrome, which is associated with prior campylobacteriosis. This was followed up in September 2013 when two delegates from the New Zealand Ministry for Primary Industries (industry regulators) discussed recent action and trends in both countries with Forbes and Strachan.

Aberdeen research insights have been used to raise awareness of food poisoning by *Campylobacter* among health practitioners and the general public through articles such as that in *The Lancet* [2]. Members of the team have also been regularly quoted in the press (e.g. *The Sunday Times*, May 2009) and asked to contribute expertise to programmes such as BBC Radio 4's *Face the Facts* (January 2013) [i,j]. In September 2013 the Aberdeen research team hosted the biannual international *Campylobacter* conference (www.chro-2013.org/) at which 450 delegates from 40 countries discussed disease burden and global concerns.

Therefore the claimed impacts as listed by REF include: disease prevention has been enhanced by research; decisions by a health service or regulatory authority have been informed by research; public awareness of a health risk has been raised. Impacts on commerce have been that industry (including overseas industry) has invested in research and development and that strategy, operations or management practices of a business have changed. Impacts on public policy and services have been that policy debate has been stimulated and moved forward by research evidence; policy decisions have been informed by research evidence. Impacts on production have been that decisions by regulatory authorities have been influenced by research. International

policy development has been influenced by research.

5. Sources to corroborate the impact

Examples of Policy Impact: UK

[a] Background to the *Campylobacter* Risk Management Programme and Joint Working Group with links to the policy paper on the development of the target for reducing *Campylobacter* in chicken production.

www.food.gov.uk/safereating/microbiology/campylobacterevidenceprogramme/

[b] Food Standards Agency, BBSRC, DEFRA, *UK Research and Innovation Strategy for Campylobacter in the Food Chain* (2010).

www.food.gov.uk/multimedia/pdfs/campylobacterstrategy.pdf

[c] The Molecular Epidemiology of Scottish *Campylobacter* Isolates from Human Cases of Infection using Multilocus Sequence Typing. CaMPS - *Campylobacter* MLST Project in Scotland Food Standards Agency (2009). {report by Aberdeen team}

www.food.gov.uk/news/newsarchive/2009/may/campylobacterinfection

[d] Private water supplies as a risk factor for *Campylobacter* infection in Aberdeen City and Aberdeenshire. {Report by Aberdeen team et al}

www.food.gov.uk/science/research/devolvedadmins/scotlandresearch/scotlandresearch/ScotlandProjectList/s14023_24/

[e] Food Standards Agency, *The Foodborne Disease Strategy for 2010-2015*. University of Aberdeen research is cited, though not named, on p14 (the proportion of human disease attributable to retail chicken sources).

www.food.gov.uk/multimedia/pdfs/fds2015.pdf;

www.food.gov.uk/aboutus/publications/busreps/strategicplan/

[f] Joint Government and Industry target to reduce *Campylobacter* in UK produced chicken by 2015. The research from the University of Aberdeen is cited as references #15, #17 on page 7 in www.food.gov.uk/multimedia/pdfs/campytarget.pdf;

www.food.gov.uk/safereating/microbiology/campylobacterevidenceprogramme/wgcampy

Examples of Policy Impact: European Union

[g] European Food Safety Authority views on *Campylobacter*.

www.efsa.europa.eu/en/topics/topic/campylobacter.htm

[h] BIOHAZ panel report in 2010 on “Quantification of the risk posed by broiler meat to human campylobacteriosis in the EU.

www.efsa.europa.eu/en/efsajournal/pub/1437.htm

Media References

[i] *Sunday Times*, 31 May 2009 *Most chickens carry food bug*.

[j] BBC Radio 4 “Face the Facts” 16 January 2013 “*Campylobacter* - the silent epidemic”.

www.bbc.co.uk/programmes/b01ptzmf

People who have provided testimonials

Director, Food Standards Agency Scotland, St. Magnus House, 25 Guild Street, Aberdeen, AB11 6NJ.

Director, WHO Centre for Risk Assessment of Pathogens in Food and Water, RIVM, Netherlands. (EFSA BIOHAZ Panel member).