

Institution: Royal Veterinary College (RVC)		
Unit of Assessment: A 6 Agriculture, Veterinary and Food Science		
Title of case study: Improved food safety through enhanced biosecurity on farms reducing campylobacter carcass contamination		
Period when the underpinning research was undertaken: 2012 – 2020		
Details of staff conducting the underpinning research from the submitting unit:		
Name(s):	Role(s) (e.g. job title):	Period(s) employed by submitting HEI:
Javier Guitian	Senior Lecturer in population medicine -> Professor of Veterinary Public Health	01/07/2002 – present
Period when the claimed impact occurred: 01/08/13 – 31/12/20		
Is this case study continued from a case study submitted in 2014? N		
1. Summary of the impact (indicative maximum 100 words)		
<p>Campylobacter is the most common bacterial cause of foodborne illness in the UK, with the societal burden estimated as costing approximately GBP710,000,000 annually. RVC quantified the effect of easy-to-deploy enhanced biosecurity and flock management measures in reducing campylobacter colonisation of chickens. This has guided recommendations made by the National Farmers Union, Food Standards Agency and British Poultry Council and led to revisions to Red Tractor and retailer standards. Consequently, >95% of UK poultry producers (farming almost one billion birds annually) now apply these measures, resulting in significantly improved food safety, a reduction in societal burden of foodborne illness and positive benefits to the poultry industry, retailers, the economy and human health.</p>		
2. Underpinning research (indicative maximum 500 words)		
<p>Research on <i>Campylobacter</i> spp. in poultry, led by Professor Javier Guitian at the RVC, has provided strong quantitative evidence of the effect of poultry management factors on carcass contamination with campylobacter. This work was commissioned by the Food Standards Agency (FSA) to inform their strategic priorities for campylobacter control and included detailed statistical analysis of an industry-led trial [1, 2].</p> <p>The effect of enhanced biosecurity, key management factors such as partial depopulation (thinning), number of empty poultry house days between flocks and the type of breed on campylobacter colonisation of chicken broilers were investigated [1, 2]. The findings provided the industry not only with evidence that these factors independently influenced risk of campylobacter colonisation, but also a quantifiable expectation of the effect in terms of degree of carcass colonisation and therefore public health impact of modifying each.</p> <p>This comprehensive analysis was followed by modelling carcass contamination parameterised using published data (including that from references 1 and 2) [3], for in-silico evaluation of the control measures identified in the intervention as well as control strategies being investigated but not yet fully implemented. This included strategies aimed at increasing resistance to colonization such as vaccines and feed additives and aimed at reducing bacterial load in colonized birds such as bacteriophages or bacteriocins. The resulting model simulation reinforced the findings of the industry intervention demonstrating how enhancement of biosecurity and cessation of thinning can be expected to be much more effective at reducing the number of UK flocks classified as 'highly contaminated' (>1000 colony forming units/g [cfu/g]) at point of slaughter than other strategies initially anticipated to be more valuable [3].</p>		

By combining comprehensive multivariable risk factor analysis based on controlled practical interventions and robust simulation modelling of the applications of these interventions across the UK poultry industry, this was the first research to convincingly quantify the likely independent effects of these on farm measures and their ability to reduce the proportion of highly contaminated carcasses.

3. References to the research (indicative maximum of six references)

1. **Georgiev M**, Beauvais W, & **Guitian J** (2017). Effect of enhanced biosecurity and selected on-farm factors on *Campylobacter* colonization of chicken broilers. *Epidemiology and Infection*, 145(3), 553–567. <https://doi.org/10.1017/S095026881600251X>
2. **Georgiev M**, Beauvais W, Downes J & **Guitian J** (2014) FSA strategic priority: Epidemiological analysis of *Campylobacter* data generated in an industry biosecurity study. Report. <https://www.food.gov.uk/sites/default/files/media/document/fs101114finreport.pdf>
3. **Crotta M, Georgiev M & Guitian J** (2017) Quantitative risk assessment of *Campylobacter* in broiler chickens—Assessing interventions to reduce the level of contamination at the end of the rearing period. *Food control*. 75, 29-39. <https://doi.org/10.1016/j.foodcont.2016.12.024>

Other Quality Indicators

The quality of Professor Guitian's research into food safety and its policy impact has led to him being able to attract funding from Biotechnology and Biological Sciences Research Council (BBSRC), Medical Research Council (MRC) Department for Environment, Food and Rural Affairs (DEFRA), Food Standards Agency, European Food Standards Agency (EFSA), The United Nations Food and Agriculture Organisation (FAO) and the Bill and Melinda Gates Foundation (BMGF) and to recruit talented researchers to engage in this work. These researchers have developed under Guitian's leadership and been appointed to important positions developing their independence in the field.

In 2017, Guitian took over leadership of a partnership between RVC and the UK's Animal Plant Health Agency (APHA), providing academic scientific leadership and support to the APHA's Epidemiological Sciences Group, being appointed to an honorary position at APHA. In 2019, RVC and APHA were awarded a joint World Organisation for Animal Health (OIE) collaborating Centre for Risk Analysis and Modelling, evidence of RVC's academic esteem in this area of epidemiological science.

The policy-oriented nature of RVC's food safety research is highlighted by the recruitment of Milen Georgiev, immediately after completion of a 3-year training period as Veterinary Public Health Resident at the RVC in 2015, by the Food Standards Agency (FSA) where he is Team Leader in Meat Hygiene Policy, and the role of Matteo Crotta, postdoctoral researcher and first author of the simulation paper, as member of the EFSA working group updating and reviewing control options for *Campylobacter* in broilers at primary production. RVC is supporting Matteo Crotta in his application for an FSA Fellowship (Jan 2021). Wendy Beauvais, a third early career researcher involved in the *Campylobacter* work, who was trained at the RVC (MSc, Residency and PhD; 2010-2016), is now Assistant Professor in Veterinary Epidemiology and Public Health at Purdue University, College of Veterinary Medicine (appointed in 2020 following a post-doctoral position in Cornell).

4. Details of the impact (indicative maximum 750 words)

Campylobacter is the most common bacterial cause of foodborne illness in the UK, with the societal burden estimated as costing approximately GBP710,000,000 annually (FSA, 2020). In 2018, it was estimated that 43,000 cases presented to general practitioners and 3,500 people with *Campylobacter* infection were hospitalised (FSA, 2020).

The FSA identified reduction of *Campylobacter* infection as a strategic priority and set up a Joint Working Group (JWG) in 2012, encompassing a wide variety of poultry industry partners and commercial organisations. The results of Professor Guitian's FSA-commissioned research were

presented at quarterly JWG meetings between 2012 and 2014 [a]. As a result of RVC findings, the JWG made a number of recommendations for changes to on-farm biosecurity practices that were widely disseminated by organisations including the National Farmers Union (NFU) and British Poultry Council (BPC). These included a *Campylobacter* Biosecurity Guide poster produced by the FSA and National Farmers Union (NFU) which was made available to all UK poultry farmers freely and disseminated widely by NFU [b]. The research also informed the BPC's Guide to Interventions (published in 2014), with regard to on farm biosecurity [c].

Red Tractor Assurance is the UK's largest farm assurance scheme, with >2000 poultry farms as members, which represent approximately 95% of the 1,000,000,000 growing chickens in the UK annually [d]. Biosecurity measures based on RVC's research have been incorporated into revised Red Tractor standards, required for compliance with the scheme [d]. These cover parent stock, hatcheries, growers, transport, and slaughter, with the whole chain independently audited to ensure compliance [d]. The changes included: The biosecure area shown on the farm map; a physical barrier (no less than 30cm high, removable/washable or replaceable) in place before entering in areas that housed birds to ensure that the houses were not contaminated, (designed to encourage behaviour change: replacing footwear, and cleaning and disinfecting before entering the house); catchers and drivers to adhere to the Biosecurity Section of manual, and mechanical harvesters added to the list of equipment requiring cleaning and disinfection [d].

These changes were proposed in 2013 following presentation of Professor Guitian's results to the JWG. All Red Tractor members were informed prior to implementation in October 2014 [d]. Biosecurity was given more prominence and thus importance for the members in ensuring compliance, through a new and separate section within the standards [d]. Requirements that farmers had to meet were sub-divided into more individual audit points to ensure consistency at audit, and clarity where corrective action was needed. Some standards were made "Key", meaning that farms may be immediately suspended from the scheme if they are not being met at any time [d].

[Text removed for publication]

Professor Guitian's research also influenced Marks and Spencer's decision to require its supply farms to cease thinning, as one of the actions in its 5-point plan introduced in 2015 to reduce contamination of the carcasses of chickens with *Campylobacter* [f], a change which was publicised in the national and trade press [g]. This included (but was not exclusive to) articles in Food Manufacture, The Grocer, Food Service Footprint, Farming UK, Environmental Health News, Daily Mail and Daily Star [g].

An M&S spokesperson said, "*At the time the food industry were under a great deal of political pressure to make changes to reduce the public health risk posed by contamination of chickens with campylobacter and Professor Guitian's work gave us confidence that this measure would have an immediate and significant effect*" [f]. M&S subsequently permitted reintroduction of thinning – economically important for the industry - after other measures, including enhanced biosecurity based on RVC's research, and blast chilling of the carcass before packing were undertaken to maintain low carcass contamination [f]. The spokesperson further stated, "*The work conducted by Professor Guitian and his colleagues truly provided a strong basis for on farm measures to be developed further and gave us confidence that these would have significant beneficial effects.*" [f]. Publicly available M&S *Campylobacter* test results for chicken stocked on the shelves of M&S stores across the UK, show that between 2015 and 2019, the yearly average proportion of meat classed as heavily contaminated (>1000cfu/g) with campylobacter reduced from 11% to 2%, and the proportion of meat with <100cfu/g – the lowest level of campylobacter contamination indicated in publically reported retailer data – increased from 55% to 91% [f].

In the UK as a whole, since dissemination of the JWG's recommendations in leading industry-wide change, the prevalence of *Campylobacter* spp. in chicken meat at retail reduced from 19.7% of highly contaminated batches in February 2014 to 3.8% in March 2018 [h]. Since 2017, the 9 major supermarket retailers have been mandated to publically report the test results for campylobacter

contamination of UK-produced fresh whole chickens they retail. Figures for April to June 2019 from these supermarkets show that only 3.6% of chickens tested positive for contamination of >1000cfu/g, which is below the FSA target maximum of 7% [h].

The BPC (whose member businesses account for approximately 90% of UK poultry production) said *“Prior to these data being obtained and modelled by Professor Guitian there was a degree of scepticism in the industry as to whether enhancing biosecurity alone could make a difference. This work truly provided the foundation for future biosecurity practices in the industry and started progress towards the successful process of reducing contamination. Such changes have increased the number of negative flocks (<10cfu/g), which can only be attributed to on-farm practices and have continued to gradually reduce campylobacter contamination in flocks overall. It is my view that enhanced biosecurity and rapid testing have played the most important part in reducing campylobacter contamination.”* [c].

Circumstantial evidence supports beneficial effects of these changes on human health. The number of reported cases in the UK per 100,000 population reduced by 14.8% between the rolling averages of 2011-2014 and 2015-2019 [i]. Furthermore, human exposure to poultry-derived products contaminated with campylobacter is only likely to have increased due to increased consumption of poultry meat in recent years. Broiler production, import of poultry meat and poultry consumption per capita have all increased in the UK over these periods ([AVEC 2017](#); [AVEC 2020](#)).

In 2020, the EFSA published an updated opinion on Campylobacter which adopted the metric used by the RVC [1] to provide a measure of the proportion of campylobacter positive flocks estimated to be linked to a specific risk factor relating to changing farm management practices [j]. This updated ESFA opinion also cites this work in showing that a downtime of more than 2 weeks for increasing campylobacter infection in the next flock (as campylobacter ingress is more likely to occur if strict biosecurity is not maintained in depopulated sheds), and was the sole study cited to provide an estimate of the role of thinning based on empirical data [j].

As such, RVC research laid the foundation for further development and refinement of on-farm measures to reduce campylobacter contamination of the carcass at slaughter which, in part, have underpinned the success of the poultry industry in reducing carcass contamination and increasing food safety in the UK and beyond.

5. Sources to corroborate the impact (indicative maximum of 10 references)

All corroborating evidence for this case has been submitted unless stated as held by RVC.

a. Letter from European Commission corroborating presentation of RVC data analysis at FSA JWG [see last paragraph of the letter, highlighted on page 3].

b. FSA and NFU biosecurity posters advising enhanced biosecurity measures and available to all poultry framers free of charge, plus email from NFU corroborating poster distribution.

- https://www.nfuonline.com/fsa-infographic-campylobacter-biosecurity-cmyk-v3-lh-250615_not-signed-o/

- <https://www.nfuonline.com/sectors/poultry/poultry-news/new-campylobacter-biosecurity-posters/>

- <https://www.nfuonline.com/sectors/poultry/poultry-news/campylobacter-poster-and-leaflet/>

c. Letter from BPC corroborating BPC quote plus the Guide to Interventions on BPC website. <https://www.britishpoultry.org.uk/a-guide-to-interventions/>

d. Letter from Red Tractor corroborating incorporation of enhanced biosecurity measures in Red Tractor Standards that affect ~95% of the 1,000,000,000 growing chickens in the UK annually.

[Text removed for publication]

f. Letter from M&S corroborating the role of RVC research in formulating its 5-point prevention plan for campylobacter, plus M&S Campylobacter Test Results October to December 2019 corroborating M&S campylobacter contamination data 2015-2019.

- <https://corporate.marksandspencer.com/campylobacter/campylobacter-oct-dec-19-v1.pdf>

g. Examples of articles publicising the M&S 5-point plan.

- <https://corporate.marksandspencer.com/media/press-releases/2014/mands-leads-on-tackling-industry-wide-campylobacter-challenge>

- <https://www.foodmanufacture.co.uk/Article/2015/10/15/Marks-Spencer-s-food-safety-plan>

- https://www.thegrocer.co.uk/buying-and-supplying/mands-rolling-out-action-plan-to-combatcampylobacter-/373837_article

- <https://www.foodservicefootprint.com/three-quarters-supermarket-chickens-contaminated-campylobacter/>

- https://www.farminguk.com/news/-unacceptable-levels-of-contamination-in-supermarketchickens_32973.html

- <http://vnonline.co.uk/vn/news/13005/Campylobacter-survey:-latest-figures-revealed>

- <https://www.dailymail.co.uk/news/article-2843379/Roast-bag-chicken-M-S-way-beat-food-bug-Supermarket-bid-beat-deadly-toxic-bacteria-kills-100-people-year.html>

- <https://www.dailystar.co.uk/news/latest-news/7-10-chickens-contain-deadly-18699894>

- <http://www.ehn-online.com/news/article.aspx?id=13814>

h. FSA Project Reports FS102121 Microbiological survey of Campylobacter contamination in fresh whole UK-produced chilled chickens at retail sale, plus FSA news article corroborating campylobacter contamination data April to June 2019 of UK-produced fresh whole chickens publicly published by the 9 main supermarket retailers.

- <https://www.food.gov.uk/print/pdf/node/680>

- [https://www.food.gov.uk/sites/default/files/media/document/campylobacter-retail-survey-jul-sept-2015%20\(2\).pdf](https://www.food.gov.uk/sites/default/files/media/document/campylobacter-retail-survey-jul-sept-2015%20(2).pdf)

- https://www.food.gov.uk/sites/default/files/media/document/campylobacter-survey-report-oct-dec-2015_0.pdf

https://www.food.gov.uk/sites/default/files/media/document/campy-survey-report-jan-mar-2016_0.pdf

- <https://old.food.gov.uk/sites/default/files/fsa-project-fs102121-year-2-report.pdf>

- <https://www.food.gov.uk/sites/default/files/media/document/campylobacter-in-chilled-chickens-year-3-2016-2017.pdf>

- <https://www.food.gov.uk/sites/default/files/media/document/campylobacter-contamination-uk-chickens-year-4-report.pdf>

- <https://www.food.gov.uk/news-alerts/news/major-retailers-publish-campylobacter-results-for-april-june-2019>

i. EFSA EU One Health Zoonosis Report 2019 [see Table 4] and EU One Health Zoonosis Report 2018 [see Table 5], plus EFSA EU summary report on zoonoses, zoonotic agents and food-borne outbreaks 2015 [see Table 10] corroborating campylobacter infection rates in people in the UK between 2011 and 2019.

<https://efsa.onlinelibrary.wiley.com/doi/epdf/10.2903/j.efsa.2021.6406>

<https://efsa.onlinelibrary.wiley.com/doi/epdf/10.2903/j.efsa.2019.5926>

<https://efsa.onlinelibrary.wiley.com/doi/epdf/10.2903/j.efsa.2016.4634>

j. EFSA Panel on Biological Hazards (BIOHAZ), Koutsoumanis K, Allende A, Alvarez-Ordóñez A, Bolton D, Bover-Cid S, Davies R, De Cesare A, Herman L, Hilbert F, Lindqvist R, Nauta M, Peixe L, Ru G, Simmons M, Skandamis P, Suffredini E, Alter T, Crotta M, Ellis-Iversen J, Hempen M, Messens W, Chemaly M. (2020) Update and review of control options for Campylobacter in broilers at primary production. *EFSA Journal* 18(4):e06090 citing RVC underpinning research. <https://efsa.onlinelibrary.wiley.com/doi/10.2903/j.efsa.2020.6090>