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Department	School of Engineering and the Built Environment
Supervisors	Dr Stathis Tingas, Dr Nick Wheelhouse, Dr Chris Guiver
Funding Status	Funded PhD Project (Worldwide)
Application Deadline	14/04/2022
Project Title	Mathematical modelling of transmission and worldwide distrubution of neglected zoonotic diseases (Q fever)

PROJECT DESCRIPTION

Query fever, commonly known as *Q fever*, is an infectious disease caused by the bacterium *Coxiella burnetii*. The bacterium causing Q fever has been detected in many host species, with farm animals (goats, sheep, cattle) and pets considered to be the main reservoirs of infection. In ruminants, the infection may cause abortions, infertility, metritis or chronic mastitis, which can lead to significant economic losses for the infected herds.

Q fever is a zoonosis, i.e., a disease that can pass from animals to humans. Transmission to human beings is mainly accomplished through inhalation of contaminated aerosols. Although Q fever is asymptomatic in 60% of human cases, it can lead to acute or chronic infections and cause flu-like syndrome, hepatitis, pneumonia, endocarditis or abortions. In humans, most cases are sporadic but outbreaks have indeed occurred in the past. Most human clinical infections occur in people handling animals or their products and this was generally not perceived as a major public health problem until 2007, when the Netherlands experienced the largest human Q fever epidemic ever described. In addition, *Coxiella burnetii* is considered a category B bioterrorism agent because it is highly infectious and resistant to physical breakdown.

In ruminants, the infection may cause abortions and infertility which can lead to significant economic losses for the infected herds. While little is known about Q fever in the UK, serological evidence suggests the disease is endemic in dairy cattle though little is actually known about the impacts of the disease. Due mainly to the epidemic in the Netherlands (2007-2010), *Q fever* has received an increase in attention as a potential source of human disease and possible preventative measures in both livestock and humans, yet there is still limited understanding on the transmission dynamics of the disease.

Hence, for public health, economic and animal health concerns, it is important to control *Coxiella burnetii* infections. However, understanding and predicting the spread of *Coxiella burnetii* in a herd or identifying such key parameters cannot be assessed by field experiments alone. In this context, mathematical epidemiological models are useful tools for understanding how the infection spreads within the herd and how various inputs (such as epidemiological characteristics of infected animals) affect the dynamics.

The objective of the project will be the development of a sophisticated mathematical model for the transmission of Coxiella Burnetti among different host species and the employment of rigorous mathematical tools for understanding the underlying mechanisms controlling its dynamics as well as identifying the optimal control strategies.

Academic qualifications

A first degree (at least a 2.1) ideally in Mathematical Biology or epidemiology or closely related disciplines with a good fundamental knowledge of applied mathematics.

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English language requirement
IELTS score must be at least 6.5 (with not less than 6.0 in each of the four components). Other, equivalent qualifications will be accepted. Full details of the University's policy are available online.

Essential attributes:

- Experience of fundamental modelling of dynamical systems
- Competent in programming
- Knowledge of deterministic mathematical modeling
- Good written and oral communication skills
- Strong motivation, with evidence of independent research skills relevant to the project
- Good time management

Desirable attributes:
Knowledge of asymptotic analysis and/or control theory.
Fundamental knowledge of compartmental models of infectious diseases.
Knowledge or machine learning algorithms.
Experience in undertaking independent research.
A completed or near completion MSc in a relevant subject area.

Indicative Bibliography	1. Keeling, M. J., & Rohani, P. (2011). *Modeling infectious diseases in humans and animals*. Princeton University Press. 2. Angelakis, E., & Raoult, D. (2010). Q fever. *Veterinary microbiology*, *140*(3-4), 297-309. 3. Guatteo, R., Beaudeau, F., Berri, M., Rodolakis, A., Joly, A., & Seegers, H. (2006). Shedding routes of Coxiella burnetii in dairy cows: implications for detection and control. Veterinary research, 37(6), 827-833. 4. Porter, S. R., Czaplicki, G., Mainil, J., Guattéo, R., & Saegerman, C. (2011). Q fever: current state of knowledge and perspectives of research of a neglected zoonosis. International journal of microbiology, 2011. 5. Rodolakis, A., Berri,M., Hechard, C., Caudron, C., Souriau, A., Bodier, C. C., ... & Arricau-Bouvery, N. (2007). Comparison of Coxiella burnetii shedding in milk of dairy bovine, caprine, and ovine herds. Journal of dairy science, 90(12), 5352-5360. 6. Agerholm, J. S. (2013). Coxiella burnetii associated reproductive disorders in domestic animals-a critical review. Acta Veterinaria Scandinavica, 55(1), 1-11.
Funding notes	This project may be funded by a scholarship of the School of Engineering and Built and Environment. Please see School-funded PhD scholarships - RESEARCH AND INNOVATION (napier.ac.uk) for information on the scholarships and how to apply for them.
Enquiries	For informal enquiries about this PhD project, please contact Dr Stathis Tingas e.tingas@napier.ac.uk
Web page	https://www.napier.ac.uk/research-and-innovation/research-degrees/application-process

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