Evaluation of a PCR test for *Coxiella burnetii* detection in dust samples in dairy cattle farms using latent class analysis

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INRA SCIENCE & IMPACT

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Aims

- Estimate the sensitivity and specificity of a PCR performed on dust samples for the detection of *Coxiella burnetii*, the agent of Q fever
- Estimate the regional prevalence and within herd dynamics of the infection in Finistère, France

Materials and methods

Data

- 95 dairy herds from Finistère, France
- Samples collected every 4 months for a year
  4 samples/herd: $\mathbf{t_1}$ to $\mathbf{t_4}$
- Bulk tank milk samples (**BTM**)
- Environmental dust samples (**DUST**) collected in lactating cow barns
- **PCR** with primers targeting the *IS1111 transposase* applied to BTM and DUST

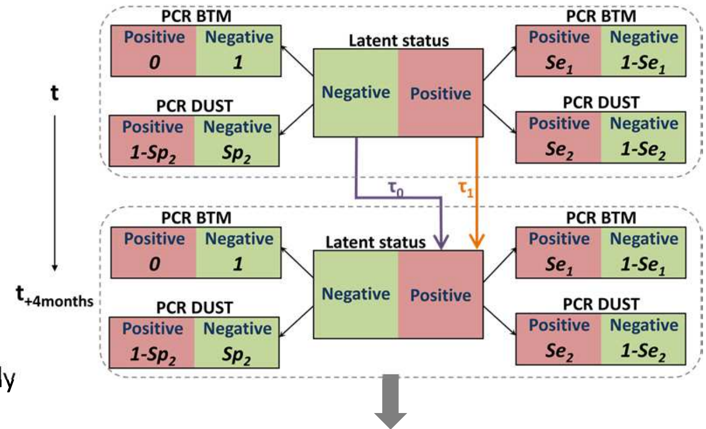
Statistical model

- Bayesian latent class model
- Occurrence of each possible test combination modelled conditionally on unobserved Latent status
- Changes in Latent status between consecutive sampling times accounted for through new infection (τ_0) and cure ($1-\tau_1$) parameters.
- Parameter estimation carried out using MCMC in OpenBUGS

Assumptions

- Specificity of 1 assumed for PCR BTM
- Priors for other parameters: Uniform(0, 1)
- Covariance between sensitivities evaluated but not significant

Representation of the statistical model for 1 farm



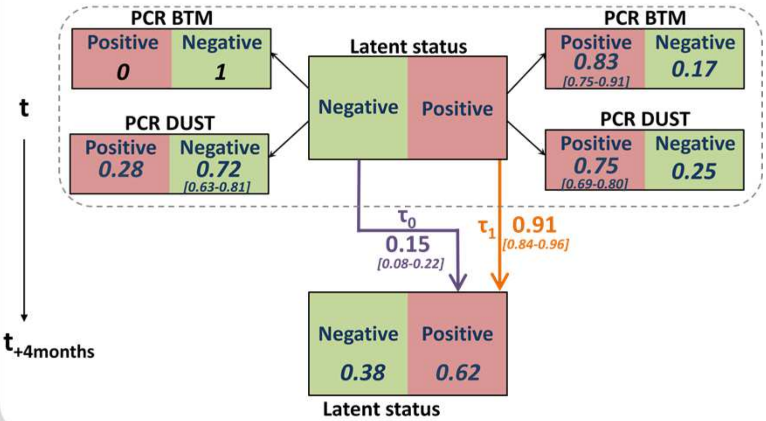
Outcome *O* of PCR BTM & PCR DUST at time *t* on farm *f*

$$O_{tf} \sim Multinomial(1, p^k_{tf})$$
$$p^1_{tf} = p(\text{PCR BTM}^+, \text{PCR DUST}^+ | S_{tf})$$
$$p^2_{tf} = p(\text{PCR BTM}^+, \text{PCR DUST}^- | S_{tf})$$
$$p^3_{tf} = p(\text{PCR BTM}^-, \text{PCR DUST}^+ | S_{tf})$$
$$p^4_{tf} = p(\text{PCR BTM}^-, \text{PCR DUST}^- | S_{tf})$$

$$p^1_{tf} = Se_1 Se_2 S_{tf}$$
$$p^2_{tf} = Se_1(1-Se_2)S_{tf}$$
$$p^3_{tf} = (1-Se_1)Se_2S_{tf} + (1-Sp_2)(1-S_{tf})$$
$$p^4_{tf} = (1-Se_1)(1-Se_2)S_{tf} + Sp_2(1-S_{tf})$$

$$S_{tf}|(S_{(t-1)f}=0) \sim Bernoulli(\tau_0)$$
$$S_{tf}|(S_{(t-1)f}=1) \sim Bernoulli(\tau_1)$$

Results and discussion



Latent status

- Latent status associated with :
  - Small probability of eliminating the infection (0.09)
  - High incidence (0.15)
- ➢ **Latent status → Active & persistent herd infection**
- High prevalence of *C. burnetii* in herds from Finistère (0.62)

PCR DUST

- Specificity = 0.72
  - False positives: bacteria in dust sample with no epidemiological role
  - Presence *C. burnetii* on farm not systematically associated with active & persistent herd infection
  - *C. burnetii* may not be as infectious as previously thought

Conclusion

The presence of *Coxiella burnetii* on farm may not always be associated with active & persistent herd infections. Bacteria transported by wind from neighbouring farms could be deposited in farm buildings without infecting cows. PCR performed on BTM is better suited to detect farms with animals shedding bacteria. PCR performed on DUST is better suited to detect presence of bacteria on farm, regardless of the presence of infectious animals. Regional prevalence is high in Finistère, France.

Reference: Nusinovici, S., Madouasse, A., Hoch, T., Guatteo, R., Beaudeau, F., 2015. Evaluation of Two PCR Tests for *Coxiella burnetii* Detection in Dairy Cattle Farms Using Latent Class Analysis. PLoS One 10, e0144608.

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