Hindcasting trends of infection With cross-sectional data

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Two diagnostics can recover the time since infection

A single, binary diagnostic test can only say whether an animal is infected or not. A quantitative test can give information on the progression of disease, but it is difficult to use a single test to distinguish a case in its early stage, from one which is in recovery. Combining two or more tests can give a unique signature for each stage of the disease progression, allowing us to estimate the time since infection (Fig 1). Combining such estimates on the population level using a bayesian framework allow us to recover elapsed and unobserved epidemic trends from cross-sectional diagnostic data, collected at a single point in time.

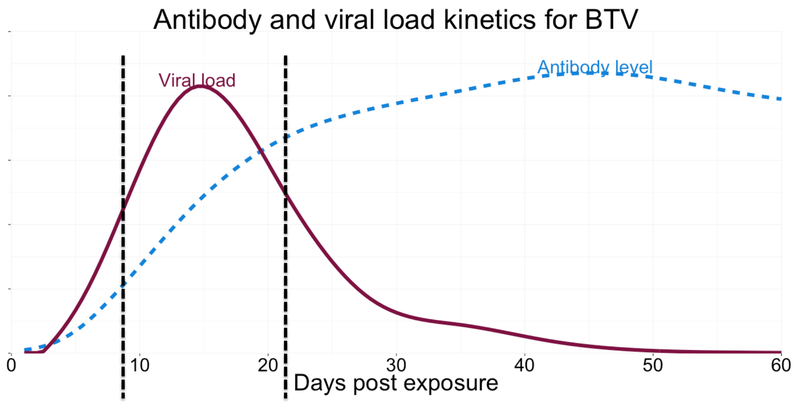

Fig 1: Combining Antibody test and Viral load for BTV gives different signatures before and after the viral peak load

Hindcasting a simulated Bluetongue outbreak

We used this approach in a case study based on the 2007 UK blue tongue outbreak. We simulated one scenario where all cases exposed thus far were sampled and tested at a single time the end of the outbreak (Fig. 2 top); and one where cases were sampled and tested at a single time, midway through the outbreak. We assumed that no information about the time since exposure was available, nor any other information about the epidemic trend. Test results were then simulated based on published temporal characteristics of BTV diagnostics.

For the bottom scenario (with 26 tested animals) , the fitted curve was nearly perfect, with an R^2 of 0.90 [0.86-0.92]. For the top scenario (with 61 tested animals) cases that had occurred up to week seven, the hindcast trend could not fully capture the erratic nature of the underlying case count data - R^2 of 0.21[0.15-0.27]. However, it did capture the approximate time that had elapsed between the start of the epidemic and the time of sampling.

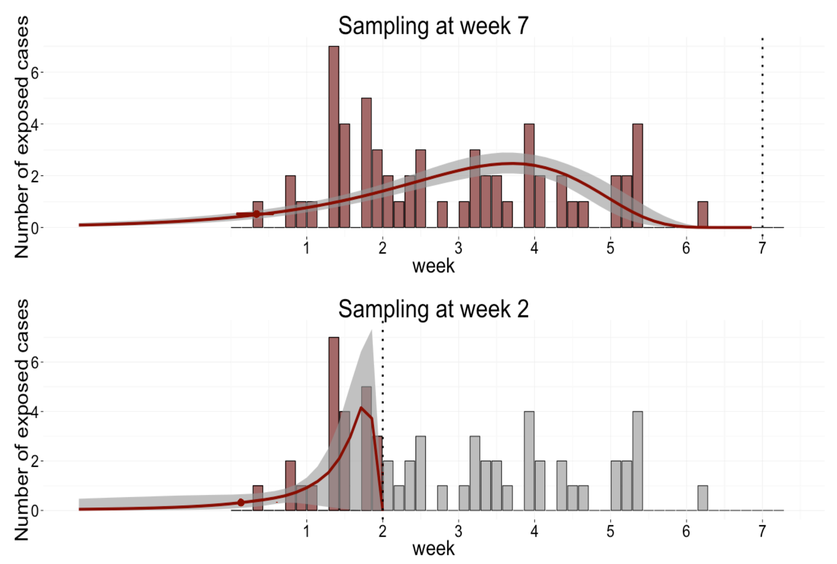

Fig 2: Recovered trend vs epicurve of the UK 2007 BTV outbreak

What type of tests should be combined?

Fig. 3: FMD test kinetics from Alexandersen (2003)

In order to maximize the benefit of collected multiple diagnostics, care should be taken that the tests used develop over different time scales. Ideally, when two test kinetics are plotted against each other over time, the resulting phase plot should display a circle.
(Fig. 4) This often corresponds to a low correlation coefficient between the two tests.

Fig 4: Phase plots of the FMD test kinetics plotted against each other.

Keep an eye out for Rydevik etal - "**Using combined diagnostic test results to hindcast trends of infection from cross-sectional data**" – Coming (hopefully) soon to a journal near you!