Output-based methodological approaches for substantiating freedom from infection

E. Meletis[1], B. Conrady[2, 3], P. Hopp[4], T. Lurier[5, 6], J. Frössling[7, 8], T. Rosendal[7], C. Faverjon[9], L. P. Carmo[10], J. J. Hodnik[11], L. Ózsvári[12], P. Kostoulas[1], G. van Schaik[13, 14], M. Nielen[13], T. Knific[15], J. Schulz[16], S. Šerić-Haračić[17], A. Madouasse[18]

[1] Department of Public and One Health, School of Health Sciences, University of Thessaly, Karditsa, 43100, Greece

[2] Department of Veterinary and Animal Sciences, Faculty of Health and Medical Sciences, University of Copenhagen, Frederiksberg, Denmark

[3] Complexity Science Hub Vienna, Vienna, Austria

[4] Norwegian Veterinary Institute, POB 64, NO-1431 Ås. Norway

[5] Université de Lyon, INRAE, VetAgro Sup, UMR EPIA, F-69280 Marcy l'Etoile, France

[6] Université Clermont Auvergne, INRAE, VetAgro Sup, UMR EPIA, F-63122 Saint-Genès-Champanelle, France

[7] Department of Disease Control and Epidemiology, National Veterinary Institute (SVA) – Uppsala, Sweden

[8] Department of Animal Environment and Health, Swedish University of Agricultural Sciences – Skara, Sweden

[9] Ausvet Europe, Lyon, France

[10] Veterinary Public Health Institute, Vetsuisse Faculty, University of Bern, Bern, Switzerland

[11] Clinic for Reproduction and Large Animals-Section for Ruminants, Veterinary faculty, University of Ljubljana, Ljubljana, Slovenia

[12] Department of Veterinary Forensics and Economics, University of Veterinary Medicine Budapest - Budapest, Hungary

[13] Department of Population Health Sciences, Unit Farm Animal Health, Faculty of Veterinary Medicine, Utrecht University – Utrecht, the Netherlands

[14] Royal GD – Deventer, the Netherlands

[15] Knific, T., Veterinary Faculty, Institute of Food Safety, Feed and Environment, University of Ljubljana, Ljubljana, Slovenia

[16] Institute of Epidemiology, Friedrich-Loeffler-Institut, Federal Research Institute for Animal Health, Greifswald - Insel Riems, Germany

[17] University of Sarajevo Veterinary faculty Sarajevo, Bosnia and Herzegovina

[18] BIOEPAR, INRAE, Oniris – Nantes, France

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For infectious cattle diseases that are not regulated, there exists a wide variety of control and surveillance programmes that are designed and implemented based on country-specific conditions. This important heterogeneity renders difficult the comparison of probabilities of freedom from infection estimated from surveillance data collected in these programmes. The objectives of this deliverable are to (I) outline the methodological and epidemiological considerations for the estimation of probabilities of freedom from infection from surveillance information (II) review state-of-the-art methods that can be used for the estimation of probabilities of freedom from infection from heterogeneous surveillance data and identify the settings in which these methods should be used.

Framed as a statistical problem, substantiating freedom from infection mostly consist in quantifying the evidence of absence from the absence of evidence. The quantification usually consists in estimating the probability of observing no positive test result in a given sampling scheme assuming that the infection is present at a chosen (low) prevalence, called the design prevalence. The usual surveillance outputs are the sensitivity of surveillance and the probability of freedom from infection. The expected cost of error, the time to detection and the outbreak size at detection can also be considered as additional outputs. There is a variety of factors that influence the choice of a method. The disease prevalence context, the performance of the tests used, the risk factors of infection, the structure of the surveillance programme and the frequency of testing should be considered in the analysis of surveillance data.

The existing methods for estimating the probability of freedom from infection, presented in the second part of the deliverable are: scenario tree modelling, Bayesian belief networks, simulation methods, Bayesian prevalence estimation methods and the STOC free model. Scenario trees analysis is the current reference method for proving freedom from infection and is widely used in countries that claim freedom (e,g, BVD in Norway). Bayesian belief networks and simulation methods are considered extensions of scenario trees. Their main advantages are that they can be applied to more complex surveillance schemes and represent complex infection dynamics. On the other hand, Bayesian prevalence estimation methods and the STOC free model are formulated using the Bayesian statistical paradigm (Bayes rule). The two methods allow freedom from infection estimation at the herd-level from longitudinal surveillance data, considering risk factor information and the structure of the population.

Comparison of surveillance outputs from heterogeneous surveillance programmes for estimating the probability of freedom from infection is a difficult task. This deliverable is a “guide towards substantiating freedom from infection” that describes both all assumptions-limitations and available methods that can be applied in different settings.