

Risk-based surveillance – a powerful alternative to conventional surveillance strategies? An evaluation study on the basis of classical swine fever in wild boar

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Abstract

To prevent disease transmission into commercial animal herds meaningful and reliable surveillance must not only focus on livestock but also wildlife. For the assessment of the overall performance of a surveillance system investigating different evaluation attributes is recommended (<http://www.fp7-risksur.eu/>). In the presented study we performed a comprehensive evaluation of alternative risk-based surveillance strategies for Classical Swine Fever (CSF) in wild boar - a disease of high economic impact. On the basis of a risk factor analysis we developed different surveillance strategies for comparative economic evaluation. The current surveillance strategy, specified by the European Union, constituted the reference strategy. To evaluate the effectiveness of the surveillance strategies we investigated sensitivity and timeliness. This was done using a simulation model. Acceptability, which provides evidence on the functional aspect of the surveillance strategies, was investigated using participatory methods. The cost-effectiveness of the surveillance strategies was investigated based on the simulation model results. Using the identified risk factors 69 surveillance strategies including the conventional strategy were generated and evaluated. Sampling only in the defined age class of sub-adult wild boar resulted in the best overall performance. The results of this study suggest that risk-based surveillance strategies can be an option to design more efficient surveillance. The study could be used as a template for further evaluation studies of surveillance of different animal diseases.

Keywords: *Evaluation, surveillance, acceptability, sensitivity, timeliness*

Introduction

For various reasons stakeholders are interested in efficient and cost-effective animal health surveillance strategies. One main reason might be the intention to fulfil international trade regulations. To ensure that available resources are used as effective as possible and the surveillance objectives are met, regular evaluation of implemented surveillance strategies is indispensable. Different tools for evaluation are currently in use; one of them is based on the determination of different evaluation attributes (1). To receive significant evaluation outcomes, the inclusion of several attributes is recommended.

With regard to the surveillance objective demonstrating freedom from a certain disease sensitivity, timeliness and acceptability are evaluation attributes advisable to investigate (2). Sensitivity is defined as the detection probability, timeliness as the time between introduction and detection of the infection and acceptability is the willingness of persons to participate or support a surveillance system.

In our study we used the German surveillance system for CSF in wild boar as an example. CSF is a reportable viral disease, which can be transmitted from wild boar to commercial pig holdings. Past outbreaks entailed huge economic consequences. The current surveillance is implemented following EU regulations (decision 2002/106/EG). Surveillance is – inter alia – based on the serological examination of at least 59 healthy shot wild boar per year and district. The examination of all wild boar detected through passive surveillance is recommended as an additional measure.

The development of effective surveillance strategies should consider risk-based surveillance as it can save resources and provide significant information. In our study we developed alternative, mainly risk-based surveillance strategies and investigated the three named evaluation attributes. In addition, we performed an economic evaluation. The aim of the study was, to identify the validity of the different surveillance strategies and compare it with the one of the currently implemented surveillance strategy for CSF in wild boar.

Materials and methods

Risk factor analyses

For the development of alternative, mainly risk-based surveillance strategies for CSF in wild boar, a comprehensive risk factor analysis was conducted. To identify risk factors for a higher probability of detection of the CSF virus and a higher probability for wild boar to get infected with the virus a literature analysis was performed. In addition, real surveillance data was used to perform statistical risk factor analyses.

Sensitivity and timeliness

To investigate sensitivity and timeliness of the different surveillance strategies a simulation model was developed. Real data was used to parametrise the model. On the

basis of real population data a wild boar population was generated. Infection data was used to simulate the increase of seroprevalence within one year. Using real hunting data wild boar was marked as shot or found dead through passive surveillance. The sampling was simulated in two ways; it was simulated randomly throughout the year and also on the basis of real surveillance data.

For the determination of sensitivity the detection probability within 12 months was calculated. For each starting month the number of simulation runs, in which infection was not detected within one year was calculated. The average resulted in the sensitivity of each surveillance strategy.

For each simulation run, in which the infection was detected within one year, it was calculated, in which of the following months the infection was detected. The weighted average was calculated and comparable values for timeliness were gained.

It was simulated that samples were examined serologically, virologically and using both methods.

Acceptability

Hunters play a key role within the surveillance system for CSF in wild boar. They usually take the samples and deliver them to the appropriate authority. Therefore, we investigated the acceptability by hunters of the current surveillance system and the newly developed alternative surveillance strategies. We implemented participatory methods, developed by CIRAD (Centre de Cooperation Internationale en Recherche Agronomique pour le Development). Focus groups of hunters of two different federal states of Germany were interviewed and proportional piling as well as several visualisation tools were applied. The acceptability of the operation and the objective of the surveillance system were evaluated. Also, the trust in the system was discussed. Finally, the acceptability of some of the alternative surveillance strategies was evaluated. Qualitative and semi-quantitative analyses were performed on the basis of Calba (3). The results of the different focus groups were finally summarised.

Cost-effectiveness

Costs were calculated for all strategies, which reached a detection probability of at least 95% within the simulation model. These strategies met the requirements of the European Commission and therefore reached 100% effectiveness.

The costs were divided into transport costs and examination costs. The transport costs included costs for the hunters driving to their hunting ground and back and costs for the system in the form of the official driver of the laboratory, which fetches the samples from the relevant authorities. The examination costs depended on the investigated strategy included either the costs for serological, for virological or for both examinations.

Summarised analyses

The evaluation attributes could not be investigated for every developed surveillance strategy. Therefore, the summarized analyses were done in blocks. In each block only the strategies, for which the same attributes were investigated, were compared. Depending on the study results for each evaluation attribute and the estimated costs the strategies were ranked in each block. For each block the strategy with the best overall performance was identified.

Results

Risk factor analyses

Summarising the literature and the statistical analyses the following risk factors were identified for a higher risk of infection with CSF or a higher probability to detect the virus: age, population density, season and samples resulting from passive surveillance. Taking these risk factors into account, 32 alternative surveillance strategies for CSF in wild boar were developed. Simulating not only serological but for some strategies also virological or both sample examinations, in total 69 strategies were investigated and compared to the performance of the currently implemented strategy.

Sensitivity and timeliness

There was no significant difference in the sensitivity and the timeliness between the random sampling throughout the year and the sampling based on real surveillance data. For the sensitivity as well as for the timeliness, the results for the strategies where samples were only examined virologically were clearly worse whereas the difference in the results when samples were examined serologically or by both methods was only minimal.

For 32 strategies, only a serological sample examination was simulated. Twenty six of them resulted in a detection probability of 95% or above. The current surveillance strategy as well as several risk-based strategies were amongst them. For 15 strategies, a virological examination was investigated. None of them reached the required 95% detection probability. From 24 strategies, which were based on serological and virological examinations, 21 reached the necessary 95%. The values for the timeliness showed a similar trend. A risk-based strategy, namely sampling only in the age class of sub-adult wild boar, showed the best value for timeliness.

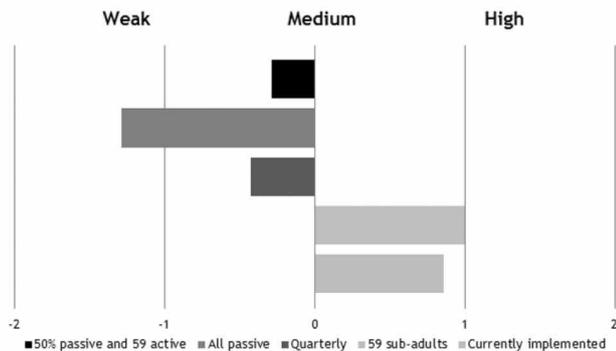
Acceptability

A total of eight group discussions were conducted, for which 28 male and one female hunter could be recruited. The estimated average age was above 50 years. Most hunters performed hunting as a hobby. They usually went hunting several times a week.

The summarised results showed with a score of 0.8 a high level of trust of the hunters in the current surveillance system. However, the acceptability of the objective of the system resulted only in a score of -0.4. The level of the acceptability of the operation of the system was with a score of -0.1 also medium. With a score of 0.9 the current surveillance strategy

was well accepted. However, sampling only sub-adult animals resulted in the best score of 1 (Figure 1).

Figure 1. Level of the acceptability of different CSF surveillance strategies in wild boar by all participating hunters of Mecklenburg-Western Pomerania and Rhineland-Palatinate.



Cost-effectiveness

Costs were only calculated for strategies, which had reached a detection probability of 95% in the simulation model. Accordingly, this was done for 47 strategies, whereby the current strategy constituted as reference strategy.

Summarised analyses

In total, the analyses were done in four different blocks. In Block 1, strategies were included, for which all evaluation attributes and the costs were investigated. The strategy, where sampling was performed only within sub-adult animals and where these samples were examined only serologically showed the best overall performance. In Block 2 the acceptability results were excluded. A strategy where sampling was only performed quarterly and samples were examined serologically and virologically resulted in the best performance. Block 3 included all evaluation attributes but costs were excluded. Again, sampling only sub-adult wild boar but examining the samples by both methods showed the best result. In Block 4, only sensitivity and timeliness were included and the same strategy as in Block 3 showed the best overall performance.

Discussion

As a CSF outbreak cannot be intentionally induced and studied a simulation model based on real data was used to investigate sensitivity and timeliness. The model is based on several assumptions, which may lead to a number of limitations. The results have to be seen in connection with the real data. For other circumstances such as other population densities the results could differ.

It was found that sampling randomly throughout the year compared to sampling based on real data did not result in huge differences in the values for sensitivity and timeliness. That can be explained by the seasonality of hunting as random sampling can only be performed when wild boar

are hunted. Detection probability and timeliness resulted in similar values, regardless of the test method (only serology or virology and serology together). These results suggest that in times of disease freedom and in areas, in which vaccination was not performed, virological examination could be avoided and therefore costs saved. The unsatisfying results if samples were only virologically examined may be due to the very short time, in which virus is detectable during infection.

The best performance of a surveillance strategy would not be helpful if the key persons involved in the system failed to accept and refused to support it. We therefore used participatory methods to study the acceptability of surveillance strategies by hunters. Participatory methods are hardly used in veterinary epidemiology in industrial countries. This can be due to the difficult interpretation of the results and the danger of subjectivity. Only 29 hunters participated in the study, which is a very small fraction of all hunters in Germany. However, it was noticed that no new information was added after the third group discussion. Therefore, a “theoretical saturation” was reached (4). Most hunters were older than 50 years and were already active hunters when CSF outbreaks occurred in wild boar in Germany. Therefore, it must be assumed that their knowledge and their opinions do not represent the average knowledge. It would be useful to extend the study and include a broader range of ages. Also, the study should be performed in German federal states, where CSF had never been present in the past. Due to limited time and resources this could not be done within the scope of this study.

The cost calculations were based on estimations; therefore, it is likely that the real costs may differ slightly. However, in our study only the tendency and the comparisons to the costs of the reference strategy were relevant. Accordingly, cost differences could be determined.

In the summarised analyses, the value of the inclusion of several evaluation attributes became evident. Only in Block 2, where acceptability was excluded, another strategy than sampling within the age class of sub-adults showed the best performance. However, this strategy (sampling only quarterly) was not very well accepted and its implementation would therefore be difficult.

In conclusion, the current surveillance strategy resulted in a good overall performance. However, the study showed that risk-based surveillance can present a cost-effective alternative and should be considered in the process of the design of animal health surveillance.

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