Outcomes From Using Mortality, Antimicrobial Consumption, and Vaccine Use Data for Monitoring Endemic Diseases in Danish Swine Herds

The aim of this study was to assess the potential of using multiple data sources currently available in Denmark for monitoring swine diseases. The study included farms that, based on serology, changed from “negative” to “positive” status for Porcine Reproductive and Respiratory Syndrome (PRRS), enzootic pneumonia (Mycoplasma hyopneumonia), and porcine pleuropneumonia (Actinobacillus pleuropneumoniae) between January 2014 and September 2017. These corresponded to 45 swine farms working as individual operation units (i.e., their disease status is independent from other farms) and 81 farms that were part of joint operation units (i.e., 2 or more farms considered to be an epidemiological unit, having swine and personnel are transferred among them, that have the same disease status). Additionally, a total of 95 farms with a negative status for these three diseases during the study period were also included in the study. Changes in mortality data, antimicrobial consumption, and vaccine use at herd level were monitored using Shewhart control charts prior to, during, and after these farms were found positive for the three diseases. The analysis was run separately for the different age groups—weaners (up to 30 kg), sows and finishers herds—within each farm. Briefly, the highest percentage of herds generating alarms was generated up to 3 months before they changed their disease status based on mortality (30%) and 1 month after based on antimicrobial use for respiratory diseases (100%). Porcine pleuropneumonia showed to be the disease with the highest impact on these data at herd level; alarms based on the three data streams were generated in the same month that herds changed their status to porcine pleuropneumonia-positive, as well as the following months. Alarms based on vaccine use generally occurred within the same month or after changes in disease status. False alarms were found in 2% (median value) of the herds for the different age groups based on mortality and antimicrobial use for respiratory diseases in healthy farms. Monitoring changes in mortality data, antimicrobial consumption, and vaccine use showed changes (i.e., warnings) at herd level prior to confirmation from diagnostic tests.
Building the foundation for veterinary register-based epidemiology: A systematic approach to data quality assessment and validation

Epidemiological studies often use data from registers. Data quality is of vital importance for the quality of the research. The aim of this study was to suggest a structured workflow to assess the quality of veterinary national registers. As an example of how to use the workflow, the quality of the following three registers was assessed: the Central Husbandry Register (CHR), the database for movement of pigs (DMP) and the national Danish register of drugs for veterinary use (VetStat). A systematic quantitative assessment was performed, with calculation the proportion of farms and observations with “poor quality” of data. “Poor” quality was defined for each measure (variable) either as a mismatch between and/or within registers, registrations of numbers outside the expected range, or unbalanced in- and outgoing movements. Interviews were conducted to make a complementary qualitative assessment. The proportion of farms and observations within each quality measure varied. This study highlights the importance of systematic quality assessment of register data and suggests a systematic approach for such assessments and validations without the use of primary data.

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Can we detect outbreaks at herd-level earlier when combining multiple data sources?
The aim of this study was to explore the potential of using multiple data sources for monitoring swine diseases

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A simulation study to evaluate the performance of five statistical monitoring methods when applied to different time-series components in the context of control programs for endemic diseases

Disease monitoring and surveillance play a crucial role in control and eradication programs, as it is important to track implemented strategies in order to reduce and/or eliminate a specific disease. The objectives of this study were to assess the performance of different statistical monitoring methods for endemic disease control program scenarios, and to explore what impact of variation (noise) in the data had on the performance of these monitoring methods. We simulated 16 different scenarios of changes in weekly sero-prevalence. The changes included different combinations of increases, decreases and constant sero-prevalence levels (referred as events). Two space-state models were used to model the time series, and different statistical monitoring methods (such as univariate process control algorithms–Shewart Control Chart, Tabular Cumulative Sums, and the V-mask- and monitoring of the trend component–based on 99% confidence intervals and the trend sign) were tested. Performance was evaluated based on the number of iterations in which an alarm was raised for a given week after the changes were introduced. Results revealed that the Shewhart Control Chart was better at detecting increases over decreases in sero-prevalence, whereas the opposite was observed for the Tabular Cumulative Sums. The trend-based methods detected the first event well, but performance was poorer when adapting to several consecutive events. The V-Mask method seemed to perform most consistently, and the impact of noise in the baseline was greater for the Shewhart Control Chart and Tabular Cumulative Sums than for the V-Mask and trend-based methods. The performance of the different statistical monitoring methods varied when monitoring increases and decreases in disease sero-prevalence. Combining two of more methods might improve the potential scope of surveillance systems, allowing them to fulfill different objectives due to their complementary advantages.

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Web of Science (2016): Indexed yes
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Web of Science (2015): Indexed yes
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Scopus rating (2014): CiteScore 3.54 SJR 1.559 SNIP 1.148
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Mortality in Danish Swine herds: Spatio-temporal clusters and risk factors

The aim of this study was to explore spatio-temporal mortality patterns in Danish swine herds from December 2013 to October 2015, and to discuss the use of mortality data for syndromic surveillance in Denmark. Although it has previously been assessed within the context of syndromic surveillance, the value of mortality data generated on a regular and mandatory basis from all swine herds remains unexplored in terms of swine surveillance in Denmark.

A total of 5010 farms were included in the analysis, corresponding to 1896 weaner herds, 1490 sow herds and 3839 finisher herds. The spatio-temporal analysis included data description for spatial, temporal, and spatio-temporal cluster analysis for three age groups: weaners (up to 30 kg), sows and finishers. Logistic regression models were used to assess the potential factors associated with finisher and weaner herds being included within multiple-herd clusters.

The spatio-temporal distribution of mortality changed over time, and suggested a general increase in mortality for the months of January and July for the three age groups. A large number of single-herd clusters (i.e. clusters with only one herd), and fewer multiple-herd clusters (i.e. clusters with at least two herds) were found. The herd size affected whether weaner herds were within multiple-herd clusters, and factors such farm type, SPF status and presence of atrophic rhinitis had an impact on finisher herds being included within multiple-herd clusters.

The higher mortality observed for the months of January and July could be linked to infrequent updates of the data used to calculate mortality. The presence of single-herd clusters might indicate welfare and disease issues, while multiple-herd clusters could suggest the presence of infectious diseases within the cluster area. The impact of farm type is linked to the fact that larger farms specialize in only one age group, with high biosecurity and more specialized personnel, and subsequently a lower mortality.

Mortality data have a potential use in disease surveillance. However, detected clusters might not be due to disease, but the result of changes such as herd management practices. Further analysis to explore other spatio-temporal monitoring methods is needed before mortality data can be incorporated into a Danish disease monitoring system.

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<td>2007</td>
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<td>SNIP 1.284</td>
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Risk factors associated with spatio-temporal clusters of high mortality in Danish swine herds

What were our motivation and objective? Mortality data are recorded to fulfill the European Commission requirements which ensures a continuous data flow for a surveillance system. Before using these data as part of a syndromic surveillance system, it is necessary to understand why increasing changes in mortality happen. The aim of this study was to identify spatio-temporal clusters of high mortality in Danish swine herds and associated risk factors.

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Risk factors associated with spatio-temporal clusters of high mortality in Danish swine herds

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What tools are useful for monitoring endemic diseases? A simulation study based on different time-series components.
Control and eradication programs play an important role in disease monitoring and surveillance. It is important to follow up on implemented strategies to reduce and/or eliminate a specific disease. The objectives of this study were to investigate...
the performance of different detection methods, including methods commonly used in biosurveillance as well as state space models, for monitoring the effect of endemic disease control and eradication programs. We simulated 16 different scenarios of changes in disease sero-prevalence, inspired by real-world data from the Danish PRRS (Porcine Reproductive and Respiratory Syndrome) monitoring program. The changes included increases, decreases and/or constant sero-prevalence levels in different combinations. Two state space models were used to model the simulated data and different monitoring methods, such as univariate process control algorithms (UPCA) and monitoring of the trend component were tested. The performance was evaluated as the proportion of iterations with an alarm for a given week. Results revealed that the different UPCA performed differently with respect to detecting increasing and decreasing changes in sero-prevalence. The trend-based methods performed well for detecting the first event but its performance was poorer in adapting to several consecutive events. The different monitoring methods had different performances in monitoring increasing and decreasing changes in disease sero-prevalence, showing that the objectives of the monitoring program should be taken into account when choosing which methods to use. The principles used in this study can also be applied in disease surveillance of (re-)emerging diseases.

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Comparing algorithms performance for monitoring endemic disease: a simulation study based on the Danish PRRSV monitoring program

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Comparing algorithms performance for monitoring endemic disease: a simulation study based on the Danish PRRSV monitoring program

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Monitoring diseases based on register data: Methods and application in the Danish swine production

The spread of diseases is one of the most important threats to animal production and public health. Disease spread causes considerable economic losses for the agricultural sector and constitutes trade-limiting factors, as transmission to countries free from disease should be avoided. Monitoring and surveillance systems are critical for the timely and effective control of infectious diseases. The ability of a system to detect changes in the disease burden depends on the choice of data source. Many factors can lead to inconsistent data collection among populations and it is therefore important to assess the quality of data before use in disease monitoring and surveillance. Over the past decade, several studies have focused on using statistical control methods to detect outbreaks of (re-)emerging diseases in the context of syndromic surveillance – both in human and veterinary medicine – in an attempt to supplement traditional sentinel surveillance. However, it may not be possible to generalize the performance of these methods to the context of other countries (where data have different characteristics), or to the context of endemic diseases. Lower incidence rates are normally expected for endemic diseases compared to highly infectious (re-emerging) diseases, due to control measures such as vaccination or health management programs. Furthermore, the data collected differ from those obtained from traditional surveillance (generally related to incidence monitoring), due to its focus on the endemic scenario, with less frequently sampled data. This reflects the added complexity of monitoring endemic diseases, as disease burden is affected not only by the incidence, but also by the duration and recovery rate. The aim of this thesis was to evaluate existing register data related to veterinary health, as a tool for monitoring swine diseases in Denmark. This included: i) describing and evaluating the quality of data (regarding the potential for disease monitoring and surveillance) in Danish databases related to swine health; ii) assessing the feasibility of studying changes in data records over time to detect changes that might indicate disease spread between swine herds; iii) evaluating the performance of different time-series methods for the monitoring and surveillance of endemic diseases, as well as assessing the impact of noise in the data on the results when using these methods. Some of the work presented was focused on endemic diseases, using Porcine Reproductive and Respiratory Syndrome (PRRS) as an example. Interviews were conducted with relevant stakeholders in order to assess the data quality of seven databases: the Central Husbandry Register (CHR), the swine movement database (SMD), the national Danish database of drugs for veterinary use (VetStat), laboratory diagnostic data from the National Veterinary Institute – Technical University of Denmark (DTU-Vet lab) and the Pig Research Centre – SEGES (VSP-SEGES lab), the Specific Pathogen Free System (SPF System) and the Meat Inspection database. The guidelines from the European Centre for Disease Prevention and Control (ECDC) for monitoring data quality and surveillance systems were used. The findings showed that limitations included delayed transfer of data to databases and incomplete representation of Danish swine herds. Laboratory submission data for testing PRRS were used to study temporal changes in data records, due to the large amount of diagnostic data available. The laboratory data proved to be useful for monitoring temporal patterns of disease occurrence. The fact that some Danish swine herds are tested monthly allows for changes in disease prevalence and incidence to be monitored, which is an example of sentinel surveillance. However, for other herds, the frequency of testing (i.e. the representativeness of the data) depends on factors such as the herd status, farmer compliance, the value of the animal, commercial purposes and ongoing control and eradication programs. This limitation did not apply to the mortality data, which is available for all Danish swine herds on a monthly basis. However, observed changes might be due to disease occurrence, or as a result of changes in herd management or a lack of accuracy in the calculation of mortality. Several scenarios representative of changes in endemic disease sero-prevalence programs were simulated to test the performance of different monitoring methods. These included univariate process control algorithms applied directly to the simulated data, as well as using the forecast errors and trend-based methods. The performance of these methods was evaluated based on the sensitivity and time taken to detect changes, which showed that some methods were more efficient than others for specific patterns. Therefore, choosing a single temporal monitoring method is challenging, and the
Objectives of the monitoring program and the differing performance of the methods in detecting a specific pattern should be taken into account. Changes in the noise of the data had an impact on the univariate process control algorithms, while the trend-based methods provided a consistent approach to monitoring changes in disease or sero-prevalence. The findings of this thesis may serve as a basis for the improvement of monitoring swine diseases in Denmark. Although the available databases have the potential for use in disease monitoring and surveillance of swine herds in Denmark, improvements are needed for accurate and real-time implementation. Further research relating to the improvement of data quality, as well as combining different data sources for monitoring endemic diseases in Denmark is needed.

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Monitoring endemic livestock diseases using laboratory diagnostic data: A simulation study to evaluate the performance of univariate process monitoring control algorithms

Surveillance systems are critical for accurate, timely monitoring and effective disease control. In this study, we investigated the performance of univariate process monitoring control algorithms in detecting changes in seroprevalence for endemic diseases. We also assessed the effect of sample size (number of sentinel herds tested in the surveillance system) on the performance of the algorithms.

Three univariate process monitoring control algorithms were compared: Shewart p Chart 1 (PSHEW), Cumulative Sum 2 (CUSUM) and Exponentially Weighted Moving Average 3 (EWMA). Increases in seroprevalence were simulated from 0.10 to 0.15 and 0.20 over 4, 8, 24, 52 and 104 weeks. Each epidemic scenario was run with 2000 iterations. The cumulative sensitivity 4 (CumSe) and timeliness were used to evaluate the algorithms' performance with a 1% false alarm rate. Using these performance evaluation criteria, it was possible to assess the accuracy and timeliness of the surveillance system working in real-time.

The results showed that EWMA and PSHEW had higher CumSe (when compared with the CUSUM) from week 1 until the end of the period for all simulated scenarios. Changes in seroprevalence from 0.10 to 0.20 were more easily detected (higher CumSe) than changes from 0.10 to 0.15 for all three algorithms. Similar results were found with EWMA and PSHEW, based on the median time to detection. Changes in the seroprevalence were detected later with CUSUM, compared to EWMA and PSHEW for the different scenarios. Increasing the sample size 10 fold halved the time to detection (CumSe = 1), whereas increasing the sample size 100 fold reduced the time to detection by a factor of 6.

This study investigated the performance of three univariate process monitoring control algorithms in monitoring endemic diseases. It was shown that automated systems based on these detection methods identified changes in seroprevalence at different times. Increasing the number of tested herds would lead to faster detection. However, the practical implications of increasing the sample size (such as the costs associated with the disease) should also be taken into account.

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Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): CiteScore 2.24 SJR 1.194 SNIP 1.295
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Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 1.032 SNIP 1.338
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Scopus rating (2008): SJR 1.056 SNIP 1.258
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Scopus rating (2007): SJR 1.009 SNIP 1.353
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Scopus rating (2006): SJR 1.06 SNIP 1.277
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 0.931 SNIP 1.414
Web of Science (2005): Indexed yes
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Web of Science (2004): Indexed yes
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Monitoring PRRS using laboratory data

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What to look for when monitoring animal diseases?

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Monitoring PRRS based on laboratory submissions: a simulation study to evaluate detection algorithms performance

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Place of publication: Belgrade, Serbia
Spatial analysis and temporal trends of porcine reproductive and respiratory syndrome in Denmark from 2007 to 2010 based on laboratory submission data

Porcine reproductive and respiratory syndrome (PRRS) has been a cause for great concern to the Danish pig industry since it was first diagnosed in 1992. The causative agent of PRRS is an RNA virus which is divided into different genotypes. The clinical signs, as well as its morbidity and mortality, is highly variable between herds and regions. Two different genotypes of PRRS virus (PRRSV) are found in Denmark: type 1 and type 2. Approximately 40% of Danish swine herds are seropositive for one or both PRRSV types. The objective of this study was to describe the temporal trend and spatial distribution of PRRSV in Danish swine herds from 2007 to 2010, based on type-specific serological tests from the PRRS surveillance and control program in Denmark using the results stored in the information management system at the National Veterinary Institute, Technical University of Denmark (DTU Vet). The average monthly seroprevalence of PRRSV type 1 was 9% (minimum of 5%; maximum of 13%) in breeding herds, and 20% (minimum of 14%; maximum of 26%) in production herds; PRRSV type 2 had an average seroprevalence of 3% (minimum of 1%; maximum of 9%) in breeding herds and of 9% (minimum of 5%; maximum of 13%) within production herds. The seroconversion rate followed a similar and consistent pattern, being higher for type 1 than for type 2 for both PRRSV types. Regarding the spatiotemporal results, the relative risk distribution maps changed over time as a consequence of the changes in PRRSV seroprevalence, suggesting a general decline in the extent of areas with higher relative risk for both type 1 and 2. Local spatial analysis results demonstrated the existence of statistically significant clusters in areas where the relative risk was higher for both herds. PRRSV type 1 seroprevalence was constantly higher than for PRRSV type 2 in both herd types. Significant spatial clusters were consistently found in Denmark, suggesting that PRRSV is endemic in these areas. Furthermore, relative risk distribution maps revealed different patterns over time as a consequence of the changes in seroprevalence.
Swine production on Maio Island, Cape Verde: a household survey

**General information**
State: Published
Organisations: National Veterinary Institute, Section for Epidemiology
Contributors: Lopes Antunes, A. C., Vieira, S., Malta, M., Nunes, T., Vaz, Y.
Pages: 155-159
Publication date: 2015
Peer-reviewed: Yes

**Publication information**
Journal: Revista Portuguesa de Ciencias Veterinarias
Volume: 110
Issue number: 595-596
ISSN (Print): 0035-0389
Ratings:
Web of Science (2019): Indexed yes
Web of Science (2018): Indexed yes
Web of Science (2017): Indexed yes
Web of Science (2015): Indexed yes
ISI indexed (2013): ISI indexed no
ISI indexed (2012): ISI indexed no
ISI indexed (2011): ISI indexed no
Original language: English
Electronic versions: antunes.pdf
Source: PublicationPreSubmission
Source-ID: 122906559
Research output: Research - peer-review › Journal article – Annual report year: 2016

The dog and cat population on Maio Island, Cape Verde: characterisation and prediction based on household survey and remotely sensed imagery

The objective was to estimate and characterise the dog and cat population on Maio Island, Cape Verde. Remotely sensed imagery was used to document the number of houses across the island and a household survey was carried out in six administrative areas recording the location of each animal using a global positioning system instrument. Linear statistical models were applied to predict the dog and cat populations based on the number of houses found and according to various levels of data aggregation. In the surveyed localities, a total of 457 dogs and 306 cats were found. The majority of animals had owners and only a few had free access to outdoor activities. The estimated population size was 531 dogs [95% confidence interval (CI): 453-609] and 354 cats (95% CI: 275-431). Stray animals were not a concern on the island in contrast to the rest of the country

**General information**
State: Published
Organisations: National Veterinary Institute, Section for Epidemiology
Contributors: Lopes Antunes, A. C., Ducheyne, E., Bryssinckx, W., Vieira, S., Malta, M., Vaz, Y., Nunes, T., Mintiens, K.
Number of pages: 5
Publication date: 2015
Peer-reviewed: Yes

**Publication information**
Estimation and characterization of the dog and cat population on Maio Island, Cape Verde: an integration of household survey data and remote sensing imagery

Companion animals are responsible for transmitting several diseases, such as toxoplasmosis, Lyme disease and rabies. The motivation for this research was to estimate the dog and cat population on Maio Island, Cape Verde, in order to implement a syndromic surveillance system as part of Vétérinaires Sans Frontières - Portugal (VSF-Portugal) project “Public Health through Animal Health”.

The study was carried out in the course of VSF - Portugal mission in October 2012. Questionnaires were applied in six localities to classify the animals according to their age, gender, sterilization and parasites control status, body condition, skin changes and other observations, degree of dependence and restriction and recorded the coordinates of feeding places for each animal. Geographic information systems tools were used to process the data and linear regression models were created with the number of houses as only predictor variable to estimate dog and cat populations. A total of 457 dogs and 306 cats were identified; Porto Inglês was the locality with the highest number of animals (272 dogs and 156 cats).

Results show that for both species, females (23.63% of female dogs and 16.90% of female cats) were sterilized in a higher percentage than males (17.09% of male dogs and 11.46% of male cats). The percentage of dewormed animals was also higher in females for both species (for dogs: 30.71% of females and 30.71% of males; for cats: 16.90% of females and 15.92% of males). Regarding the degree of dependence and restriction, the results indicated that the majority of
animals were classified as restricted or supervised animals (59.3% of dogs and 60.46% of cats) and as family animal (38.73% of dogs and 36.93% of cats). Porto Inglês was the only village where feral (1% of dogs, 0.33% of cats) and neighbour (0.88% of dogs, 2.29% of cats) animals were reported. The estimated population size on the island was 531 dogs and 354 cats. The models for these estimations were based on 400 m and 200 m resolutions respectively and resulted in an error of 7% when compared to survey results.

In summary, this study allowed a direct contact with a culture where small companion animals have an important social status; and stray animals were not a concern on Maio Island in contrast with other islands in Cape Verde. Remotely sensed data and GIS tools were crucial to accomplish the objective of this study, revealing that this methodology is an added value in terms of assessing population sizes when financial resources are restricted.

**General information**
State: Published
Organisations: University of Lisbon, Avia-GIS, Universidad Autónoma de Madrid, Universidade Técnica de Lisboa
Contributors: Lopes Antunes, A. C., Ducheyne, E., Bryssinckx, W., Vieira, S., Malta, M., Vaz, Y., Nunes, T., Mintiens, K.
Publication date: 2014
Peer-reviewed: Yes
Event: Abstract from VI Congresso da Sociedade Portuquesa de Ciências Veterinárias, Oeiras, Portugal.
Electronic versions: LivroResumos_VICongressoSPCV2014.pdf

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**Estimativa e caracterização da população de cães e gatos na ilha do Maio, Cabo Verde: Integração entre dados de um recenseamento e imagens de detecção remota**

**General information**
State: Published
Organisations: National Veterinary Institute, Section for Epidemiology, Avia-GIS, Veterinários Sem Fronteiras, Ministério do Desenvolvimento Agrário
Contributors: Lopes Antunes, A. C., Ducheyne, E., Bryssinckx, W., Vieira, S., Malta, M.
Number of pages: 1
Publication date: 2014
Peer-reviewed: Yes
Event: Poster session presented at VI Congresso da Sociedade Portuquesa de Ciências Veterinárias, Oeiras, Portugal.
Electronic versions: poster_caes_gatos_SPCV_14_03_12.pdf
Source: PublicationPreSubmission
Source-ID: 102535254
Research output: Research - peer-review › Poster – Annual report year: 2014

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**Opportunities and challenges of using diagnostic databases for monitoring livestock diseases in Denmark**

Several databases are being used in Denmark to record information at all stages and levels of modern livestock production. These databases are all developed for different purposes and gather large volumes of routinely collected data. Examples of existing databases for livestock are the Central Husbandry Register (CHR), Meat inspection database for cattle and swine, mortality database and movement database. These databases are owned by the Ministry of Food, Agriculture and Fisheries. Other databases, such as the Danish Cattle Database, are owned by the agricultural sector. In addition to the technical and political bottlenecks of gathering and combining data from the different databases, the questions remain on the sensitivity and timeliness of data for detecting unexpected animal health events. Thus, it is important to explore changes in data records over time from different databases in order to detect potential patterns. This includes describing trends, seasonality and the potential impact of covariates on the baseline patterns. The potential of these data as monitoring tools can be evaluated using performance indicators such as residuals, predictive positive values, sensitivity and specificity, and by comparing the predictions of models with previous diseases events in Denmark. A further challenge is to identify the most adequate surveillance timescale (i.e. daily, weekly or monthly basis) as well as suitable spatial distances, in order to identify outlier events when the features of the alarm (e.g. shape and amplitude) are unknown. Using rule-based anomaly detection will allow developing a spatio-temporal monitoring framework based on time-series analysis and statistical process control in order to optimize methods for detection of anomalies in data patterns and methods for early warning. It is expected that the use of such information in space and time, might provide information which can be used either directly as a syndromic surveillance tool or to aid in a more targeted or directed disease surveillance program. This will enable a timely and appropriate response to a disease outbreak, minimizing economic impacts through timely implementation of disease prevention and control measures.
Opportunities and challenges of using diagnostic databases for monitoring livestock diseases in Denmark
Several databases are being used in Denmark to record information at different stages and levels of modern livestock production gathering large volumes of routinely collected data. This poster describes an ongoing PhD project at the National Veterinary Institute of the Technical University of Denmark with the objective of developing a monitoring framework based on spatiotemporal analysis to optimize methods for detection of anomalies in submission patterns and methods for early warning.

Produção de suínos na Ilha do Maio, Cabo Verde: sistemas de criação e saúde animal

Spatiotemporal analysis of the Porcine Reproductive and Respiratory Syndrome epidemic in Denmark using laboratory submission data

Spatiotemporal analysis of the Porcine Reproductive and Respiratory Syndrome (PRRS) epidemic in Denmark using laboratory submission data
Porcine reproductive and respiratory syndrome (PRRS) virus infects domestic swine populations causing production losses in many European countries. The virus has two different strains designated as European (EU) and American (US) strain. It has been assumed that 30% of Danish swine herds are sero-positive with one or both PRRS strains. The PRRS surveillance program is based on serology tests performed in a monthly or annual basis for the breeding and intensive production herds respectively. The objective of this study was to characterize the PRRS epidemic in Denmark from 2007 to 2010 using retrospective spatiotemporal analysis of serological tests. Records of PRRS serology submissions made from January 2007 to December 2010 stored in the DIANOVA Information Management System at the National Veterinary Institute (DTU Vet) were used in the analysis. Each submission consists in individual blood samples collected for surveillance purposes and its frequency depends on the herd type. The herds were classified as PRRS positive or negative based on the individual serology test results for both virus strains. The prevalence of both PRRS strains was calculated on a monthly basis for the breeding and intensive production herds. The herd numbers registered in the laboratory submissions were merged with the Danish Herd Identification System database, in order to obtain the geo-coordinates of the herds. Spatiotemporal analysis was performed, in order to characterize PRRS-EU and PRRS-US distributions for both control levels.

The analyses indicated a seasonal pattern in the between-herd prevalences of PRRS-EU and PRRS-US for both herds type. The prevalence of both PRRS strains was higher in the intensive production herds (mean=37%) when compared with the breeding herds (mean=17%). The spatiotemporal analysis detected a number of clusters of PRRS-EU and PRRS-US in both herd types. This suggests that PRRS still disperse between herds and that additional control efforts should be considered.

**General information**
State: Published
Organisations: National Veterinary Institute, Section for Epidemiology
Contributors: Lopes Antunes, A. C., Toft, N., Hisham Beshara Halasa, T.
Publication date: 2014
Peer-reviewed: Yes
Event: Abstract from 8th Annual Meeting of Epizone, Copenhagen, Denmark.

**Bibliographical note**
Poster abstract, EP101
Source: PublicationPreSubmission
Source-ID: 100223123
Research output: Research - peer-review › Conference abstract for conference – Annual report year: 2014

**Swine production on Maio Island, Cape Verde: rearing systems and animal health**
The objective was to assess which swine rearing systems are used and swine’s health in Maio Island, in order to plan future strategies to improve animal and public health.

The study was carried out in the course of Vétérinaires Sans Frontières - Portugal mission in October 2012. A household survey was conducted in Alcatraz, Calheta, Figueira da Horta, Morro, Morrinho and Porto Inglês. The number of swine, gender, age, rearing system and its health was recorded. The clinical signs of dead animals were also documented. In a total of 1526 households, 305 swine producers were identified with an average of 4.26 animals (4.20 – 4.32) per producer. Results showed that piglets (54.89%) and females (31.18%) represented the main age and sex groups. Regarding the rearing system, 57.59% of owners reported that their animals were remain confined in piggeries, 33.99% had free access to the streets and only 8.5% lived in backyards. A total of 271 animals died in 2010 (30), 2011 (140) and 2012 (101). Although the majority of swine producers (48.69%) do not report any clinical signs prior to the animal’s death, tremble (15.69%), hyperemia of the skin (13.40%), abortion (4.92%), recumbence (0.65%) and respiratory distress (0.33%) were described for some cases. Mortality occurred between April and October, being the months of August and September mentioned by 7.53% of the producers.

The symptoms described by producers may indicate the presence of certain infectious diseases, such as African Swine Fever, easily spread in free breeding systems. However, other causes such as toxic plants, should be consider since mortality occurred mainly in the warmest months, coinciding with the rainy season when many owners free their animals to feed of existing plants in the fields. Future strategies should be focused in further laboratory investigation in order to identify cause of swine’s death. Despite of the awareness of the population to the potential presence of certain diseases on the island, it is important to continuous current ongoing projects which address the trainee of those people to recognize clinical signs, to report it to responsible authorities and to improve diagnosis, preventive and control strategies.

**General information**
State: Published
Organisations: University of Lisbon
Contributors: Lopes Antunes, A. C., Vieira, S., Malta, M., Nunes, T., Vaz, Y.
Publication date: 2014
Peer-reviewed: Yes
Event: Abstract from VI Congresso da Sociedade Portuguesa de Ciências Veterinárias, Oeiras, Portugal.

**Swine production on Maio Island, Cape Verde: rearing systems and animal health**
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**General information**
State: Published
Organisations: University of Lisbon
Contributors: Lopes Antunes, A. C., Vieira, S., Malta, M., Nunes, T., Vaz, Y.
Publication date: 2014
Peer-reviewed: Yes
Event: Abstract from VI Congresso da Sociedade Portuguesa de Ciências Veterinárias, Oeiras, Portugal.
Electronic versions:
Swine production on Maio Island, Cape Verde: rearing systems and animal health

Objective: To characterise swine rearing practices and adverse health events on Maio Island, in order to plan future strategies to improve animal and public health.

General information
State: Published
Organisations: University of Lisbon
Contributors: Lopes Antunes, A. C., Vieira, S., Malta, M., Nunes, T., Vaz, Y.
Number of pages: 1
Publication date: 2014
Peer-reviewed: Yes
Electronic versions:
ANTUNES_AC_SVEPM2014.pdf
Research output: Research - peer-review › Poster – Annual report year: 2014

Projects:

Disease databases
The general purpose of the project is to explore the potential use and value of different data sources as a monitoring tool for detection of diseases in Danish swine herds. The project is a continuation of the PhD project "Veterinary Epidemiology with the focus on monitoring livestock disease using diagnostic databases", in which different databases and monitoring methods were explored in the context of endemic diseases. As a starting point, the project will be focused on methods to detect changes in mortality and to find possible links among diseases occurrence, antibiotic usage, and other data streams (such as meat inspection and laboratory diagnostic data).
Lopes Antunes, A. C., Project Participant, National Veterinary Institute, Epidemiology
Jensen, V. F., Project Participant, National Veterinary Institute, Epidemiology
Toft, N., Project Manager, National Veterinary Institute, Epidemiology
01/01/2017 → 31/12/2019
Project: Research

Veterinary Epidemiology with focus on monitoring livestock disease using diagnostic databases
Lopes Antunes, A. C., PhD Student, National Veterinary Institute
Toft, N., Main Supervisor, National Veterinary Institute
Hisham Beshara Halasa, T., Supervisor, National Veterinary Institute
Jensen, V. F., Examiner, National Veterinary Institute
Revie, C. W., Examiner
Mortensen, S., Examiner
Offentlig finansiering
15/12/2013 → 26/04/2017
Award relations: Veterinary Epidemiology with focus on monitoring livestock disease using diagnostic databases
Project: PhD

Activities:

Translating danish pig big data into useful data for monitoring diseases
Period: 9 Oct 2018
Ana Carolina Lopes Antunes (Invited speaker)
Epidemiology
National Veterinary Institute
Related event

**MSD High Quality Pork EU 2018**
09/10/2018 → 10/10/2018
Baveno, Italy
Activity: Talks and presentations › Conference presentations

**High Quality Pork LATAM 2018**
Period: 13 Aug 2018 → 15 Aug 2018
Ana Carolina Lopes Antunes (Guest lecturer)
National Veterinary Institute
Epidemiology
Degree of recognition: International

Related event

**High Quality Pork LATAM 2018**
13/08/2018 → 15/08/2018
Lima, Peru
Activity: Talks and presentations › Conference presentations

**Can we detect outbreaks at herd-level earlier when combining multiple data sources?**
Period: 16 May 2018 → 18 May 2018
Ana Carolina Lopes Antunes (Guest lecturer)
National Veterinary Institute
Epidemiology
Degree of recognition: International

Related event

**InnovSurv 2018**
16/05/2018 → 18/05/2018
Montpellier, France
Activity: Talks and presentations › Conference presentations

**Interactive, web-based health data visualisation with RStudio Shiny**
Period: 26 Mar 2018 → 28 Mar 2018
Ana Carolina Lopes Antunes (Participant)
National Veterinary Institute
Epidemiology
Degree of recognition: International

Related event

**Interactive, web-based health data visualisation with RStudio Shiny**
26/03/2018 → 28/03/2018
Uppsala, Sweden
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

**What to look for when monitoring endemic disease? Translating large volumes of data into valuable data for disease surveillance**
Period: 5 Mar 2018
Ana Carolina Lopes Antunes (Invited speaker)
National Veterinary Institute
Epidemiology
High quality pork 2018
05/03/2018 → 06/03/2018
Da Nang, Viet Nam
Activity: Talks and presentations › Conference presentations

Risk factors associated with spatio-temporal clusters of high mortality in Danish swine herds
Period: 4 Oct 2017
Ana Carolina Lopes Antunes (Guest lecturer)
National Veterinary Institute
Epidemiology

Description
Presented at the ECVPH AGM & Annual Scientific Conference 2017
Degree of recognition: International
Documents:
Proceedings -ECVPH-2017-v06

Related event
ECVPH AGM & Annual Scientific Conference 2017
02/10/2017 → 04/10/2017
Liege, Belgium
Activity: Talks and presentations › Conference presentations

How can we improve public health, food hygiene, and animal welfare in developing country slaughterhouses?
Period: 3 Oct 2017
Ana Carolina Lopes Antunes (Organizer)
National Veterinary Institute
Epidemiology
Degree of recognition: International

Related event
How can we improve public health, food hygiene, and animal welfare in developing country slaughterhouses?
03/10/2017 → …
Liege, Belgium
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

ECVPH AGM & Annual Scientific Conference 2017
Period: 2 Oct 2017 → 4 Oct 2017
Ana Carolina Lopes Antunes (Organizer)
National Veterinary Institute
Epidemiology

Related event
ECVPH AGM & Annual Scientific Conference 2017
02/10/2017 → 04/10/2017
Liege, Belgium
Activity: Attending an event › Participating in or organising a conference

Modelling of disease spread
Period: 5 Jun 2017 → 23 Jun 2017
Ana Carolina Lopes Antunes (Participant)
National Veterinary Institute
Epidemiology
Related event

Modelling of disease spread
05/06/2017 → 23/06/2017
Lyngby, Denmark
Activity: Other

International Conference in Animal Health Surveillance 3
Period: 1 May 2017 → 4 May 2017
Ana Carolina Lopes Antunes (Speaker)
National Veterinary Institute
Epidemiology
Degree of recognition: International

Related event

International Conference in Animal Health Surveillance 3
01/05/2017 → 04/05/2017
Rotorua, New Zealand
Activity: Talks and presentations › Conference presentations

What tools are useful for monitoring endemic diseases? A simulation study based on different time-series components.
Period: 1 May 2017 → 4 May 2017
Ana Carolina Lopes Antunes (Speaker)
National Veterinary Institute
Epidemiology
Degree of recognition: International

Related event

International Conference in Animal Health Surveillance 3
01/05/2017 → 04/05/2017
Rotorua, New Zealand
Activity: Talks and presentations › Conference presentations

PhD boot camp - scientific writing
Ana Carolina Lopes Antunes (Participant)
National Veterinary Institute
Section for Epidemiology

Description
PhD boot camp - scientific writing

Related event

PhD boot camp - scientific writing
16/08/2016 → 18/08/2016
Ringsted, Denmark
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

24th International Pig Veterinary Society (IPVS) Congress
Period: 7 Jun 2016 → 10 Jun 2016
Ana Carolina Lopes Antunes (Participant)
National Veterinary Institute
Section for Epidemiology
24th International Pig Veterinary Society (IPVS) Congress
07/06/2016 → 10/06/2016
Dublin, Ireland
Activity: Attending an event › Participating in or organising a conference

University of Southern Denmark
Ana Carolina Lopes Antunes (Visiting researcher)

National Veterinary Institute
Activity: Visiting an external institution › Visiting another research institution

Dynamic generalized linear models for monitoring endemic diseases: moving beyond univariate process monitoring control algorithms.
Period: 17 Mar 2016
Ana Carolina Lopes Antunes (Speaker)

National Veterinary Institute
Section for Epidemiology

Annual Conference of The Society for Veterinary Epidemiology and Preventive Medicine 2016
Ana Carolina Lopes Antunes (Participant)

National Veterinary Institute
Section for Epidemiology

Annual Conference of The Society for Veterinary Epidemiology and Preventive Medicine 2016
16/03/2016 → 18/03/2016
Helsingør, Denmark
Activity: Attending an event › Participating in or organising a conference

SVEPM 2016 Poster Prize
Ana Carolina Lopes Antunes (Other)

National Veterinary Institute
Section for Epidemiology

Annual Conference of The Society for Veterinary Epidemiology and Preventive Medicine 2016
Ph.D. Student

SVEPM: Annual Meeting 2016
16/03/2016 → 18/03/2016
Elsinore, Denmark
Activity: Attending an event › Participating in or organising a conference
Trace back and trace forward in foodborne outbreak investigation
Period: 16 Mar 2016
Ana Carolina Lopes Antunes (Participant)
National Veterinary Institute
Section for Epidemiology

Related event
Trace back and trace forward in foodborne outbreak investigation
16/03/2016 → …
Elsinore, Denmark
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

Monitoring PRRS using laboratory data
Period: 3 Feb 2016
Ana Carolina Lopes Antunes (Speaker)
National Veterinary Institute
Section for Epidemiology

Related event
Up to date with Pig Research
03/02/2016 → …
Copenhagen, Denmark
Activity: Talks and presentations › Conference presentations

Up to date with Pig Research
Period: 3 Feb 2016
Ana Carolina Lopes Antunes (Speaker)
National Veterinary Institute
Section for Epidemiology

Description
Monitoring PRRS using laboratory data

Up to date with Pig Research

Related event
Up to date with Pig Research
03/02/2016 → …
Copenhagen, Denmark
Activity: Talks and presentations › Conference presentations

International trade of animal source foods from low income countries
Period: 8 Oct 2015
Ana Carolina Lopes Antunes (Participant)
National Veterinary Institute
Section for Epidemiology

Related event
International trade of animal source foods from low income countries: The good, the bad and the ugly
08/10/2015 → …
Belgrade, Serbia
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

Annual General Meeting of the European College of Veterinary Public Health 2015
Ana Carolina Lopes Antunes (Participant)
National Veterinary Institute
Section for Epidemiology

Related event

Annual General Meeting of the European College of Veterinary Public Health 2015
07/10/2015 → 09/10/2015
Belgrade, Serbia
Activity: Attending an event › Participating in or organising a conference

Food and Agriculture Organization of the United Nations (FAO) Participatory Epidemiology Forum
Period: Oct 2015 → …
Ana Carolina Lopes Antunes (Participant)
National Veterinary Institute
Epidemiology
Degree of recognition: International
Links:
Activity: Other

Training School on Big Data and Data Warehousing
Period: 27 Aug 2015
Ana Carolina Lopes Antunes (Participant)
Department of Applied Mathematics and Computer Science
National Veterinary Institute

Related event

Training School on Big Data and Data Warehousing
26/08/2015 → 28/08/2015
Denmark
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

Introduction to Bayesian Disease Mapping
Period: 29 Jun 2015 → 3 Jul 2015
Ana Carolina Lopes Antunes (Participant)
National Veterinary Institute
Section for Epidemiology

Related event

Introduction to Bayesian Disease Mapping
29/06/2015 → 03/07/2015
Edinburgh, United Kingdom
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

Syndromic surveillance using free tools
Period: 19 May 2015 → 22 May 2015
Ana Carolina Lopes Antunes (Participant)
National Veterinary Institute
Section for Epidemiology

**Related event**

**Syndromic surveillance using free tools**
19/05/2015 → 22/05/2015
Uppsala, Sweden
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

**International Conference in pig welfare**

Period: 29 Apr 2015 → 30 Apr 2015
Ana Carolina Lopes Antunes (Participant)

National Veterinary Institute
Section for Epidemiology

**Related event**

**International Conference in pig welfare: Improving pig welfare - what are the ways forward?**
29/04/2015 → 30/04/2015
Copenhagen, Denmark
Activity: Attending an event › Participating in or organising a conference

**Annual Conference of The Society for Veterinary Epidemiology and Preventive Medicine**

Ana Carolina Lopes Antunes (Participant)

National Veterinary Institute
Section for Epidemiology

**Related event**

**Annual Conference of The Society for Veterinary Epidemiology and Preventive Medicine**
25/03/2015 → 27/03/2015
Ghent, Belgium
Activity: Attending an event › Participating in or organising a conference

**Introduction to the Interactive visualisation of surveillance data with Google maps and Charts**

Period: 25 Mar 2015
Ana Carolina Lopes Antunes (Participant)

National Veterinary Institute
Section for Epidemiology

**Related event**

**Introduction to the Interactive visualisation of surveillance data with Google maps and Charts**
25/03/2015 → …
Ghent, Belgium
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

**Symposium: Animal Health Surveillance 2.0 RISKSUR**

Period: 24 Mar 2015
Ana Carolina Lopes Antunes (Participant)

National Veterinary Institute
Section for Epidemiology
Symposium: Animal Health Surveillance 2.0 RISKSUR
24/03/2015 → …
Ghent, Belgium
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

National Veterinary Institute Sweden
Period: Feb 2015 → Mar 2015
Ana Carolina Lopes Antunes (Visiting researcher)
National Veterinary Institute
Epidemiology
Activity: Visiting an external institution › Visiting another research institution

Epidemiological analysis of clustered data – with emphasis on veterinary applications
Period: 15 Jan 2015 → 4 Feb 2015
Ana Carolina Lopes Antunes (Participant)
National Veterinary Institute
Section for Epidemiology

Spatial and Temporal Statistical Modelling for Population Health Sciences Course
Period: 24 Nov 2014 → 28 Nov 2014
Ana Carolina Lopes Antunes (Participant)
Section for Epidemiology
National Veterinary Institute

Related event
Spatial and Temporal Statistical Modelling for Population Health Sciences Course
24/11/2014 → 28/11/2014
Liverpool, United Kingdom
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

8th Annual Meeting of Epizone
Period: 23 Sep 2014 → 25 Sep 2014
Ana Carolina Lopes Antunes (Participant)
National Veterinary Institute
Section for Epidemiology

Description
Porcine Reproductive and Respiratory Syndrome (PRRS) epidemic in Denmark using laboratory submission data

Related event
8th Annual Meeting of Epizone: Primed for tomorrow
Copenhagen, Denmark
Activity: Attending an event › Participating in or organising a conference
Workshop on Communication  
Period: 23 Sep 2014  
Ana Carolina Lopes Antunes (Participant)  
National Veterinary Institute  
Section for Epidemiology

Related event

Workshop on Communication: YOUNG EPIZONE  
23/09/2014 → …  
Copenhagen, Denmark  
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

1st Dairy Care Conference  
Ana Carolina Lopes Antunes (Participant)  
National Veterinary Institute  
Section for Epidemiology

Related event

1st Dairy Care Conference  
22/08/2014 → 23/08/2014  
Copenhagen, Denmark  
Activity: Attending an event › Participating in or organising a conference

2nd International Conference on Animal Health and Surveillance  
Period: 7 May 2014 → 9 May 2014  
Ana Carolina Lopes Antunes (Participant)  
National Veterinary Institute  
Section for Epidemiology

Related event

2nd International Conference on Animal Health and Surveillance  
07/05/2014 → 09/05/2014  
Havana, Cuba  
Activity: Attending an event › Participating in or organising a conference

Data mining and knowledge discovery – an introductory course with focus on veterinary epidemiology applications  
Period: 4 May 2014 → 6 May 2014  
Ana Carolina Lopes Antunes (Participant)  
National Veterinary Institute  
Section for Epidemiology

Related event

Data mining and knowledge discovery – an introductory course with focus on veterinary epidemiology applications  
04/05/2014 → 06/05/2014  
Havana, Cuba  
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

VI Congresso da Sociedade Portuguesa de Ciências Veterinárias  
Period: 3 Apr 2014 → 5 Apr 2014  
Ana Carolina Lopes Antunes (Participant)  
National Veterinary Institute
Section for Epidemiology

Related event

VI Congresso da Sociedade Portuguesa de Ciências Veterinárias: Ciências Veterinárias - Praxis e Futuro
03/04/2014 → 05/04/2014
Oeiras, Portugal
Activity: Attending an event › Participating in or organising a conference

How to estimate the risk of exotic disease incursion
Period: 26 Mar 2014
Ana Carolina Lopes Antunes (Participant)
National Veterinary Institute
Section for Epidemiology

Related event

How to estimate the risk of exotic disease incursion
26/03/2014 → …
Dublin, Ireland
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

SVEPM Annual Meeting 2014
Ana Carolina Lopes Antunes (Participant)
National Veterinary Institute
Section for Epidemiology

Related event

SVEPM Annual Meeting 2014
26/03/2014 → 28/03/2014
Dublin, Ireland
Activity: Attending an event › Participating in or organising a conference

Euraxess Career Roadshow
Period: 11 Mar 2014
Ana Carolina Lopes Antunes (Participant)
National Veterinary Institute
Section for Epidemiology

Related event

Euraxess Career Roadshow
11/03/2014 → …
Copenhagen, Denmark
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

Up to date with pig research
Period: 29 Jan 2014
Ana Carolina Lopes Antunes (Participant)
National Veterinary Institute
Section for Epidemiology

Related event

Up to date with pig research
Prizes:

**InnovSurv 2018 Poster prize**
Ana Carolina Lopes Antunes (Recipient)
National Veterinary Institute, Epidemiology

**Details**
Awarded date: 18 May 2018
Degree of recognition: International
event: InnovSurv 2018
Prize: Prizes, scholarships, distinctions

**MSD Animal Health names 2018 High Quality Pork Ph.D. award**
Ana Carolina Lopes Antunes (Recipient)
National Veterinary Institute, Epidemiology

**Details**
Awarded date: 2018
Degree of recognition: International
Prize: Prizes, scholarships, distinctions

**Roberto Chizzoline Memorial Poster Award 2017**
Ana Carolina Lopes Antunes (Recipient)
National Veterinary Institute, Epidemiology

**Description**
Poster presented at the ECVPH AGM & Annual Scientific Conference 2017

**Details**
Awarded date: 4 Oct 2017
Degree of recognition: International
Granting Organisations: European College of Veterinary Public Health
Prize: Prizes, scholarships, distinctions

**YOUNG EPIZONE Poster Prize**
Ana Carolina Lopes Antunes (Recipient)
National Veterinary Institute, Section for Epidemiology

**Description**
Poster Prize at EPIZONE 8th Annual meeting

**Details**
Awarded date: 24 Sep 2014
Prize: Prizes, scholarships, distinctions

Press clippings:

**Ana Carolina Antunes: a veterinária apaixonada por big data e data science**
Ana Carolina Lopes Antunes
13/02/2019
National Veterinary Institute, Epidemiology

**Media contribution (1)**

**Ana Carolina Antunes: a veterinária apaixonada por big data e data science**
13/02/2019
Veterinária Atual - Veterinários pelo mundo (National), Portugal, Print
Vandt pris med forenklede beskrivelser og flot design
Ana Carolina Lopes Antunes
02/01/2018
National Veterinary Institute, Epidemiology

Media coverage (1)

Vandt pris med forenklede beskrivelser og flot design
02/01/2018
DTU Avisen (National), Denmark, Print
DTU
http://emagstudio.win.dtu.dk/DTU-avisen/DTUavisen1801/page_1.html
KREATIVITET Ana Carolina Lopes Antunes vandt en posterpris ved et årsmøde i Belgien.

Uudforsked data giver ny viden om svins dødelighed
Ana Carolina Lopes Antunes
19/12/2017
National Veterinary Institute, Epidemiology

Media coverage (1)

Uudforsked data giver ny viden om svins dødelighed
19/12/2017
Denmark, Web
Ana Carolina Lopes Antunes
Press/Media: Press / Media