“EVIDENCE-BASED VETERINARY MEDICINE (EBVM): EPIDEMIOLOGIE IN DIENST VAN DE PRAKTIJK”

30 oktober 2015

HOGENT

CAMPUS MELLE

studiedag ingericht door

PROCEEDINGS

OF THE

22^{th} ANNUAL MEETING OF THE

FLEMISH SOCIETY FOR

VETERINARY EPIDEMIOLOGY AND ECONOMICS

EVIDENCE BASED VETERINARY MEDICINE

Editors: S. Ribbens & Y. Van der Stede

30 Oktober 2015

MELLE, BELGIUM

Organiserend comité

Y. Van der Stede (voorzitter), S. Roelandt (ondervoorzitter), G. Hendrickx (secretaris), E. Wauters (penningmeester), B. Balis, K. De Clercq, J. Dewulf, L. Lauwers, S. Ribbens, T. Meyns, P. Depoorter, J. Charlier

Wetenschappelijk comité proceedings

Y. Van der Stede (Voorzitter), P. Depoorter, B. Balis, J. Charlier, D. Maes, S. Ribbens

STUDIEDAG INGERICHT DOOR DE

VEE VZW

IN SAMENWERKING MET

HOGESCHOOL GENT
MELLE

* * *

PROGRAMMA

“EVIDENCE-BASED VETERINARY MEDICINE: epidemiologie in dienst van de praktijk”

8h30-9h15	Onthaal met koffie en koffiekoeken
9h15-9h30	Verwelkoming door HoGent en voorzitter VEE

OCHTEND PROGRAMMA

Plenaire sessie: Jeroen Dewulf

9h30-9h40	Inleiding van de keynote speakers *Prof. Dr. J. Dewulf*
9h40-10h30	Use of data to support veterinary herd health in dairy cows *Dr. M. Hostens & Dr. B. Van Ranst (BoviVets)*
10h30-11h20	Using technical performance health statistics to tackle future challenges in poultry production *Dr. H. van Meirhaeghe (VetWorks)*
11h20-11h50	koffiepauze
11h50-12h40	Epidemiology in practice: can we learn from companion animal veterinarians? *Dr. D. Brodbelt (RVC-London)*
12h40-14h00	Lunch met postervoorstelling

NAMIDDAG PROGRAMMA

Open session: sessievoorzitter: Stefaan Ribbens

14h00-14h10	Inleiding van de namiddagvoordrachten
14h10-14h30	Dr. H. Nijs ‘’Veterinary Syndromic Surveillance in Belgium: Indicators of importance and evaluation of aberration detection algorithms using historical mortality data with regard to the 2006- 2007 BTV epidemics’
14h30-14h50	Dr. S. Sarrazin: ‘A descriptive study to assess the perception of cattle farmers towards the implementation of biosecurity’
14h50-15h10	Dr. S. Welby: ‘Surveillance of bovine tuberculosis: What benchmark to expect at slaughterhouse and during purchase testing?’

15h10-15h45	Koffiepauze en postersessie

<u>Open session: sessievoorzitter: Johannes Charlier</u>

15h50-16h10	Prof. Dr. J. Dewulf ‘Antimicrobial use and biosecurity practices in pig production in four European countries, comparison, associations and opportunities’
16h10-16h30	Dr. C Rojogimeno ‘Farm-economic analysis of reducing antimicrobial use whilst adopting good management strategies on farrow-to-finish pig farms’
16h30-16h50	Dr. F. Vangroenweghe: ‘Seasonal variation in prevalence of different respiratory pathogens during post-weaning and fattening period in Belgian and Dutch pig herds using a trachea-bronchial swab technique’
16h50-17h-00	Poster Prijs AVIA-GIS en afscheidswoord voorzitter VEE
17h00-18h00	**Receptie aangeboden door HoGent**

Oral presentations

USE OF DATA TO SUPPORT VETERINARY HERD HEALTH IN DAIRY COWS

Sander Moerman, Kristof Hermans, Bonny Van Ranst, Geert Opsomer, Miel Hostens
Department of Reproduction, Obstetrics and Herd Health, Faculty of Veterinary Medicine, Ghent University, Salisburylaan 133, 9820 Merelbeke, Belgium
Corresponding author: Miel Hostens, miel.hostens@ugent.be

1. Introduction

During last decades, the dairy industry has been scaling from small family business to large facilities with hundreds, or even thousands of animals. Simultaneously, through the development of microcomputers, mobile devices, the world wide web, automatic milking systems, sensor technology and uncountable software applications, a tremendous increase of data collection has been established (Krogh & Enevoldsen, 2012; Kinsel, 2013; Rutten et al., 2013). This evolution of technology was accompanied with the search for new management methods, especially for maximizing efficiency and minimizing input by the decrease of labor costs (Jacobs & Siegford, 2012). Already in the late eighties, farms using information technology showed improved profitability (Lazarus, 1990). Nowadays, the collected data and records with information about production, fertility and youngstock have proven to be one of the most powerful assets on dairy herds (Bach & Ahedo, 2008).

The velocity of the data collection or the rate at which data gets collected, has increased following a similar pattern to that of volume. As mentioned by Cole et al. (2012), the human ability to gather data has outpaced the speed of data analysis. Overall, this has resulted in a shift the way data is presented towards the data consumers. With time, raw data is no longer represented as such. It is preprocessed in calculations, algorithms and visualization tools in order to make the life of the data consumers easier (Jacobs, 2009). The latter creates a setting where one is first and foremost an information user and no longer a straight data consumer.

This information user, being farm staff, veterinarians and other consultants, does not longer wants to process the data himself but rather prefers to receive an easy and quick-to-interpret report of the data and the actual performance status of the dairy herd. Hence, the raw data has to be visualized suitably. However, people should be aware of the possible threats in data visualization and interpretation.

Providing information is possible in two major ways: by a list of numbers or through the use of charts. The human brain is better developed to comprehend a graph than a series of numbers (Cukier, 2010). On top, group averages increase the risk for misinterpretation. Although charts have been proven to be the better option to display data, general rules have been defined when using graphs (Senay & Ignatius, 1990).

The present paper aims to make the reader familiar with common interpretation errors when using numbers and aims to show how these can be avoided through the use of appropriate visualization methods.

2. Interpretation

The interpretation of data is dual: on the one hand there is a need for deep domain knowledge which should be available for all people involved in the dairy industry such as herd managers, veterinarians, nutritionists and consultants. On the other hand, a basic knowledge of data analysis is necessary to overcome classical interpretation errors. Unfortunately, the latter is often missing in the aforementioned stakeholders.

2.1.Data format

Numbers are not just numbers. Before interpreting and evaluating KPIs (Key Performance Indicators), one should be aware of how these KPIs are established and what is necessary for their correct interpretation. Key performance indicators are in fact assemblies of raw data lists extracted from events (e.g. heats, inseminations and results of pregnancy checks in case of fertility KPIs). This raw data is aggregated and assembled, leading to a calculation. This calculation can result in a simple average (e.g. average daily milk production, age at first insemination, age at first calving) or in a more complex KPI such as the Dutch standardized milk yield (BSK) calculation which allows to compare daily milk production of cows in different parities and days in milk, etc. (CRV, 2014). Other, more complex KPIs are milk production prediction models and more economically oriented KPIs such as net gain per cow per year (CRV, 2015). The result of these calculations provides the herd manager with useful information about processes such as milk production and fertility allowing him to compare the current performances to the predefined objectives. An inherent trait of each calculation or KPI, is the fact they are calculated within a specific dimension. One of the most important dimensions is time. This can be either day, month, quarter, year or any other time span. Time as a data dimension is hierarchical: days can be grouped in months, months in quarters and quarters in years. This allows to aggregate and summarize data. The second important dimension is the group in which a KPI is calculated, meaning that the KPI is only calculated for a defined group of animals. This group may be composed according to a certain parameter, being place (e.g. region, country), animal group (e.g. whole herd, only 1st lactation cows) or people (e.g. farmer, veterinarian or technician carrying out the inseminations). These dimensions determine whether a KPI is calculated either cross-sectional or in a cohort. A cross-sectional calculation measures a KPI at a certain moment in time. A cohort follows a certain group of animals with the same property, for example the milk production of those cows that have calved in February or March, over a longer period of time. This is visualized in **Chart 1**.

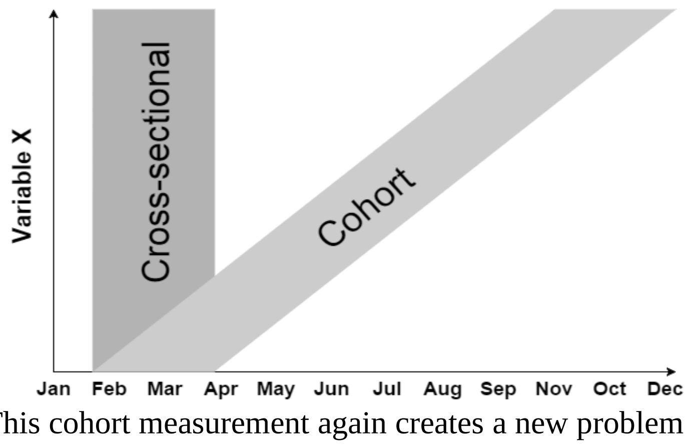

Chart 1: *This chart explains the difference between a cross-sectional and a cohort measurement. The X-axis shows the calendar date in months. The Y-axis shows variable X. A cross-sectional measurement is a snapshot on a certain moment in time. For example the average daily milk production in February and March. A cohort measurement is the opposite: the same measurement is been made over a period of time. For example the average daily milk production from February to December of cows that have calved in February and March.*

This cohort measurement again creates a new problem for an adequate interpretation. Because of the fact that the size of the cohort groups can strongly influence the reliability of the KPI. For example, if we consider an increase in conception rate from 30 % to 35 %, in theory, with a power of 80 % and a significance level of 5 %, 1375 animals should be included in the calculation to accurately label this raise as being significant.

On top, the collected data isn't always normally distributed. The latter has consequences for the interpretation of numbers such as mean, median and mode which is often the case when using only a list of number to evaluate a process. This is shown figure X where we use the amount of animals per lactation number, which is generally not normally distributed. If we should consider this parameter as normally distributed, averages would be completely different (**Chart 2**).

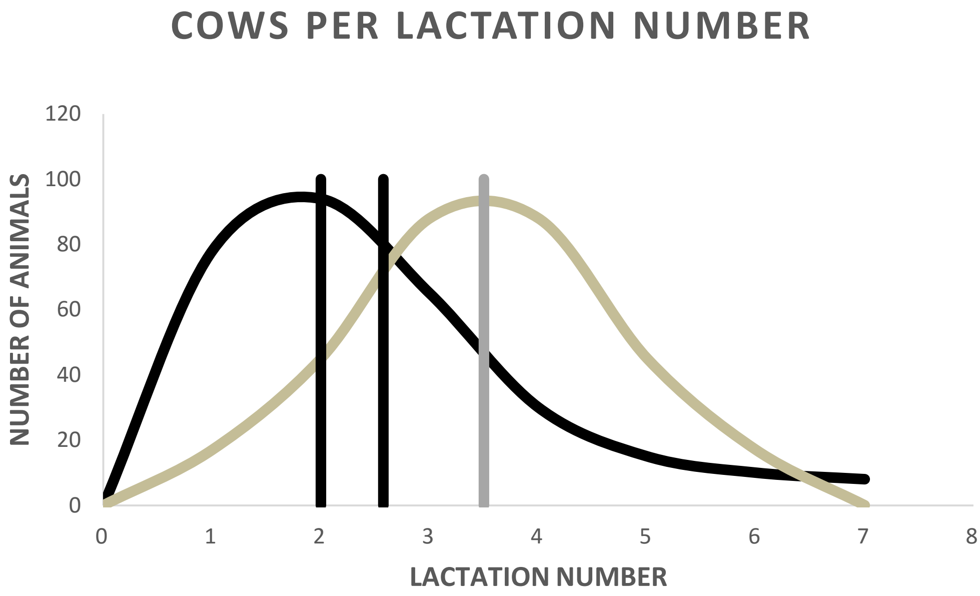

Chart 2: *A line chart showing the difference between non-normally and normally distributed data. We considered a total of 300 animals and plotted them according to their lactation number. The black curve line shows the distribution in reality, the grey curve line shows a virtual normal distribution. The vertical lines show the average, mean and mode for both distributions. For the normal distribution, as well the average, the median as the mode are the same (3.5). For the non-normal distribution, the average is 2.57 while the median and mode are both 2. This shows the major differences between normal and non-normally distributions when evaluating averages.*

2.2.Interpretation pitfalls

Once a KPI has been calculated, there are some major pitfalls when it comes to interpreting the KPI accurately. Especially when using numbers instead of charts to evaluate a KPI, four major concepts increase mis- or over-interpretation of data: variation, lag, momentum and bias (Eicker et al., 2006).

2.2.1. Variation

All business processes are prone to variability (Rodriguez, 2010). Especially in biological processes such as milk production and reproduction wherein animals, cows, weather and people are actors, variation is inherent (Fraser, 2001). Hence, a first and classical pitfall in data interpretation is the possible misunderstanding or ignorance of variation in data records.

Variation is known as the deviation from the mean. It’s a measure for the scatter of a certain data set. As people are eager to use averages for evaluating and comparing group or herd parameters, variation is a threat for correct data interpretation as averages usually hide those individual animals that need special attention (van der Leek, 2015). Hence, it is more important to focus on variation rather than on averages (Guterbock, 2001). Van der Leek (2015) approaches this as follows: “monitor averages, manage outliers”. He also refers to two methods to monitor variation in data: statistical process control (Risco et al., 2007; De Vries & Reneau, 2010) and cohort analysis (Smith, 2012). Statistical process control (SPC) is a collection of tools to monitor, control and improve processes by using statistical analysis (De Vries &

Reneau, 2010). Statistical process control has the ability to detect variation and to determine if this variation is within its normal range. Otherwise, SPC can be applied to evaluate the effect of change implemented by the operator. Two sources of variation are known in processes: assignable-cause and chance-cause variation (Montgomery, 2009). Chance-causes are small unavoidable causes whereas assignable-causes are identifiable and result in extra variation. One of the best known SPC tools are Shewhart control charts. In these charts, statistics are applied to observations plotted over time (De Vries & Reneau, 2010). These charts have a central tendency line and an upper and lower limit of significance. If these limits are crossed, the process is considered to be out of control and intervention is necessary (De Vries & Reneau, 2010).

Next to SPC, variation can be monitored through the use of cohort analysis. When using cohort analysis, the herd is subdivided in several smaller groups called cohorts. For each of these groups, statistics are applied. This leads to a more effective evaluation of management changes (Smith, 2012).

Too much variation in a process is often an indication that the process isn't controlled well by its administrator. Variation can be visualized using histograms or line charts (**Chart 3**).

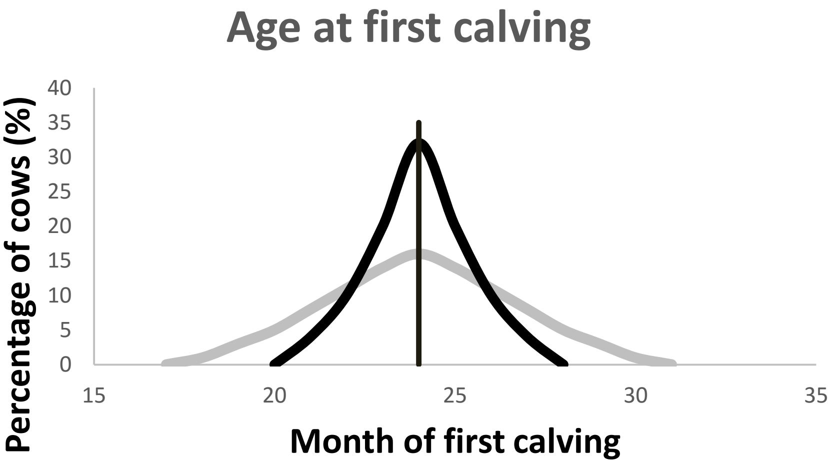

Chart 3: *A line chart showing variation in a dairy process. On the X-as: age at first calving (months). The age of 24 months is considered as being optimal. For as well the grey as the black chart, the average is 24. Nevertheless, we prefer the black chart due to the fact that there is less variation.*

Applied in dairy management, an excellent example of the importance of variation is provided by Bach (2010) where he states that an average age at first calving of 26 months can be better than the ideal of 24 months if the variation is respectively 24 to 28 months and 18 to 30 months.

2.2.2. Momentum

A second pitfall in data interpretation is called momentum. Momentum occurs when historic data mask or blur actual performances. In particular, this is the case when performance parameters are evaluated over a longer period of time. It is known as the responsiveness of averages to recent changes in performances. Momentum can occur in two opposite ways: inferior historical performances can cover current good performances; excellent historic performances can blur current substandard performances. For example, when analyzing insemination risk or heat detection rate – the percent of eligible cows that are inseminated within a given time frame, usually 21 days (Overton, 2009) – the average rate over the past couple of months may not be representative for the rate during the last month. Again, when visualizing this KPI in a chart (**Chart 4**) the influence of momentum becomes clear.

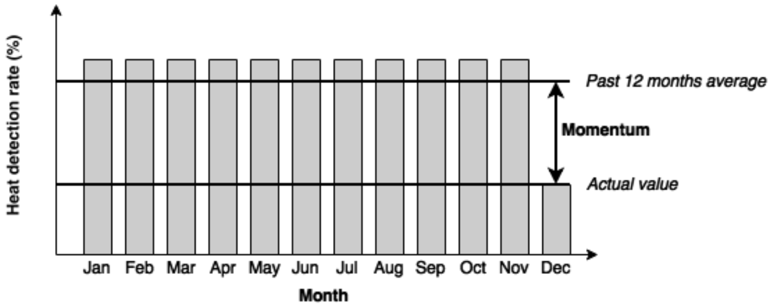

***Chart 4**: In this bar chart, momentum is explained using heat detection rates (HDR). The actual heat detection rate (Dec) is too low. If we evaluate HDR as the average since January (past 12 months average), heat detection is mistakenly considered as acceptable. The gap between the actual value and the past 12 months average represents the momentum.*

The most obvious solution to avoid momentum in data interpretation, is to evaluate only recent data such as those of the last month. However, this isn't always possible because an inherent characteristic of analyzing short term data is that less records are involved. Especially when evaluating data from smaller herds or groups, records over a longer period of time are necessary to have a sufficient amount of animals included in a calculation. This can be demonstrated using the Insemination Risk (IR). If we consider two animals being included in the calculation and one of them is not inseminated, we get a reduction of the IR of 50% percent. If we should have 10 animals included in the calculation and one animal is not inseminated, this reduction is only 10%. Hence, the timespan in which the calculation is made should always be in balance with the amount of animals.

2.2.3. Lag

Lag can be defined as the period between the moment an event occurs and the moment it is measured and evaluated (Eicker et al., 2006). For example, if due to a recent reproductive problem cows are having difficulties to get pregnant, this will not have an effect on the historical calving interval during the following 9 months. Conversely, when the historical calving interval suddenly increases, this is likely to be the effect of a reproductive problem that was ongoing 9 or more months ago. We tried to visualize this in **Chart 5**.

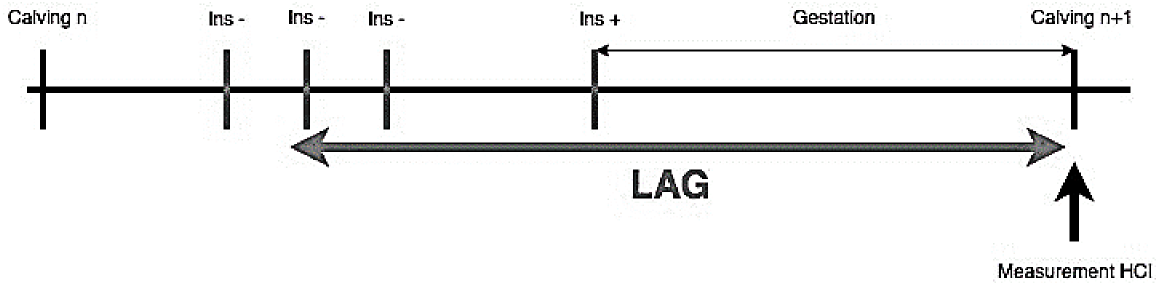

***Chart 5**: In this graph, lag is explained using the historical calving interval (HCI). The HCI can only be measured after two or more calvings. Gestation is a fixed period of 280 days. The length of the HCI is determined by the period between previous calving and the latest successful insemination (Ins +). This period is situated more than 280 days before calculation of HCI, leading to a lag time of at least 280 days (Ins - : unsuccessful insemination, Ins + : successful insemination).*

2.2.4. Bias

Bias is defined as a systemic error in data. Steineck and Ahlbom (1992) proposed a definition for bias according to three steps in data analysis: the data base, data collection and the actual analysis. "*The first step generates confounding, the second results in misclassification and misrepresentation, and the third produces analysis deviation. The total bias is the sum of the confounding, misclassification, misrepresentation, and analysis deviation.*" In practice, "the data base" is the most notable source of bias. It is caused by a particular inclusion or exclusion

of individuals when calculating a certain parameter. This inclusion/exclusion can be either *incorrect* or either be *inherent to the calculation*. A well-known example of bias *inherent to the calculation* is the one created by the historical calving interval wherein only cows are included that have calved twice or more. Cows that have calved just once, and which are supposed to possess the best genetics in the herd, are not included in the calculation due to fact that a historical calving interval is calculated on at least two calvings.
Incorrect inclusion/exclusion arises when wrong animals or events are included in the calculation. For example, an incorrect inclusion of animals in a calculation is made when cows in the herd that are excluded from breeding for non-reproductive reasons (e.g. udder or lameness problems), are still included in calculations of reproductive performance indicators. By including them in the calculation of a fertility KPI, these cows lower the reproductive performances of the herd, although they have no reproductive problems. A common cause of this problem is the fact that farmers do not record those animals as “not to breed”. Hence, software programs consider these animals ready to be served and to get pregnant.
Logically, bias also occurs when data is missing or incomplete (Nebel et al., 2007).

3. Visualization

As already mentioned, visualization is a useful tool to avoid the pitfalls and thereby misinterpretation of numbers. Because, unlike its limited short time memory, the human brain is extremely well developed when it comes to recognizing visual patterns in data. As recognizing data patterns is mainly a psychological phenomenon, the Gestalt laws can be applied to data visualization. The Gestalt effect is a theory which describes the ability of the human brain to translate a number of individual elements such as points and lines into whole cohesive forms (Wertheimer, 1923; Kohler, 1929). The Gestalt effect can be summarized as the fact that the whole is bigger than the sum of the elements.

The Gestalt theory includes six major Gestalt laws from which five of them are shown in **Chart 6**. They play a major role in the unconscious interpretation of charts (Chang et al., 2002; Peebles & Ali, 2009; Ali & Peebles, 2013; Wertheimer, 1938). The first law handles about closure, referring to the fact that people tend to ignore gaps and complete contour lines. (2) The second law is the one of proximity, as people intend to see objects near each other as one big object. (3) The third law is the one of continuity. The human brain groups objects as one as they are co-linear or following the same direction. (4) The fourth law, the one of figure and ground, handles about the fact that viewers always view an object and a background. (5) The fifth law, the one of similarity, refers to the fact that objects with the same attributes are likely to be grouped as one. (6) The sixth and most important law is the law of “Prägnanz”, meaning succinctness. It refers to the fact that the brain loves simple elements instead of complicated shapes. Therefore this law is also called the law of Simplicity. All these laws ensure that people can easily – and usually unconsciously - recognize patterns in visualized data.

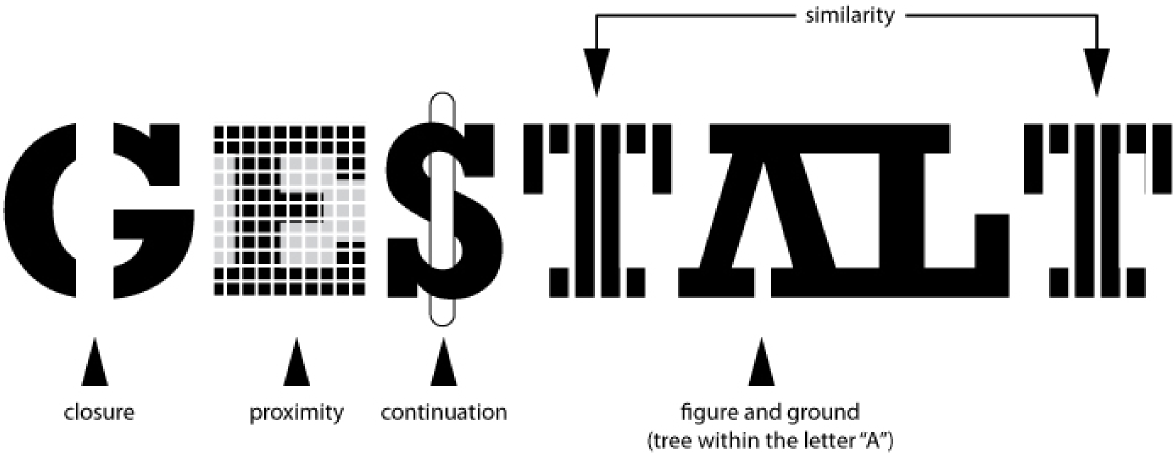

Chart 6: The Gestalt principles explained using one figure. The law of Simplicity is not shown.

Card et al. (1998) defined visualization as the use of interactive visual representation of abstract data to amplify cognition. Visualization is the ultimate way to discover patterns in data sets derived from dairy herds or cows. An excellent example to support this statement is provided by Anscombe (1973). In his four graphs - the Anscombe quartet - as well the number of observations, the mean of the x's, the mean of the y's, the regression coefficient of y on x, the equation of the regression line, the sum of squares, the regression sum of squares, the residual sum of squares of y, the estimated standard error and multiple R^2 are exactly the same. Nevertheless, the pattern of the data in his graphs was totally different.

We reproduced and simplified (with only the averages considered as being the same) his graphs using the amount of milk per day in correlation with the days in milk for four virtual groups of five cows. For each group a scatter plot was created simulating milk per day and days in milk. In all groups, the average for amount of milk and for days in milk is 20 kg/day and 50 days respectively. The result is shown in **Chart 7**.

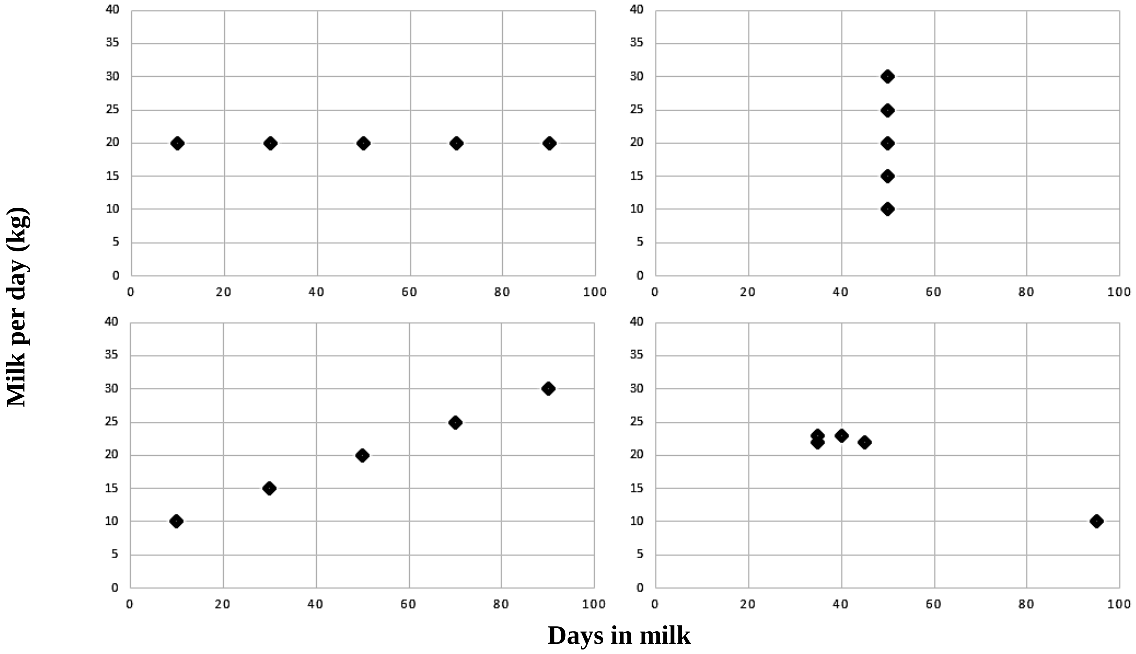

Chart 7*: Each of the 4 graphs contains data of 5 individual cows. The average amount of milk per day and days in milk for each group is the same, being 20 kg and 50 days respectively. However, big differences between the groups can be noticed after visualizing the data in scatter plots.*

As seen in **Chart 7**, although the averages are the same, the distribution of the data is completely different. This proves again why it is important to visualize data. For example, in case of the graph in the right bottom, the outlier would not have been detected when only using numbers.

Peebles and Cheng (2003) divided extraction of information out of charts in three factors: the cognitive abilities of the user, the graphical properties of the external representation, and the specific requirements of the task. This means, how powerful charts can be to communicate data, they can also mislead people. The accessibility to user-friendly software for non-experts has only encouraged this (Pandey et al., 2015). The misrepresentation of data in charts, whether on purpose or not, is called deceptive visualization. Already in the early fifties, Darrell Huff warned against this threat (Huff, 1954). Pandey et al. (2015) recently categorized deceptive visualization in two groups: message reversal and message exaggeration/understatement, the first group showing the data wrong (yes becomes no), the second group showing the data in wrong proportions. They also proposed a definition for deceptive visualization : "*a graphical depiction of information, designed with or without an intent to deceive, that may create a belief about the message and/or its components, which varies from the actual message*". They executed a crowdsourced user study to investigate the effect of four deceptive visualization techniques. Although further research is necessary in the future, the effect of deceptive visualization techniques on chart interpretation was clear.

CONCLUSIONS

Data has been proven to be a valuable asset in veterinary herd management. However, the people who are interested in this data, being farm staff, consultants, veterinarians, often lack knowledge about data handling and management. Therefore, it is necessary to transform the collected raw data into useful information to help end users when making decisions in their management. Commonly the raw data is translated into numbers such as averages. However, when only using numbers, a lot of information gets lost. For example, an average does not take into account critical process properties such as variation. Especially in a biological environment with cows, people and weather as varying factors, variation is unavoidable and should be limited to the minimum. Other important issues when presenting a KPI as a number, are bias, lag and momentum. Visualization of this data can help to handle these issues.

Data visualization is valuable to extract information out of raw data. Through the use of some well-chosen charts such as line charts, bar charts and scatter plots the user is provided with easily accessible data containing much more information than just a list of numbers. Although these visualization methods are of great help in veterinary data management, they cannot be used without any risk. When charts are designed in a wrong way, whether on purpose or not, they can be misleading. Deceptive visualization is the phenomenon where a chart is designed in a way which makes it hard to interpret the data in a correct way. Therefore users have to be aware of the basic rules of data visualization.

USING TECHNICAL PERFORMANCE AND HEALTH STATISTICS TO TACKLE FUTURE CHALLENGES IN POULTRY PRODUCTION.

[1]T. Dugardin,[2]M. De Gussem, [2]H. Van Meirhaeghe
[1]DEGUDAP BVBA – Sasstraat 8 – B- 8870 IZEGEM, Belgium
[2]VETWORKS BVBA – Knokstraat 38 – B- 9880 POEKE, Belgium

SUMMARY
The poultry production is facing new challenges: the consumer demands a good quality product that meets the highest food safety standards. A mayor concern is to reduce antimicrobial resistance in humans, by using less antibiotics in animal production. This is an opportunity for the poultry veterinarian to take up his role as expert in health advice and support in profitable farm management.

Evidence based veterinary medicine can support the veterinarian together with the farmer in the decision making process for an optimal treatment or management changes.

Several projects and studies are ongoing, to set up data collection systems not only to record the use of antibiotics, but also to point out risk factors with data on health status, management, biosecurity, technical and economic performance in broiler farms.

INTRODUCTION
The role of the veterinarian has evolved from animal life saver to guardian of animal health and wellbeing, and especially in production animals as gatekeepers of food safety. We hereby have to keep the economic interest of our clients in mind and be aware of consumers demands. Challenges for the poultry industry in 2015 are providing a good quality product in a sustainable way and warranting food safety. One of the main concerns is to reduce antimicrobial resistance in humans and animals by reducing the use of antibiotics in animal production. In Belgium animal producers and veterinarians have taken the engagement to reduce antibiotic use by 50% and the use of critical antibiotics by 75% in 2020 (AMCRA 2020). A data collection system of antibiotic use is essential to follow up the evolution and also to benchmark farmers and veterinarians.

The pressure to reduce antibiotics is a challenge, but also an opportunity for the poultry industry. Better understanding the risk factors leading to antimicrobial use –AMU-will lead to improvements and new ideas in the whole chain of poultry production. The aim is to maintain or even improve performance with less antibiotics.
Several projects and studies are ongoing, to set up data collection systems to evaluate risk factors for development of antimicrobial resistance: not only to record the use of antibiotics, but also data on health status, management, technical and economic performance in broiler farms.

EFFORT is a EU project that will collect data in different EU countries in a standardised way and provide guidelines to set up new tools for poultry veterinarians to reduce antimicrobial use and to optimise management in broiler farms with good ROI for the farmer.

EFFORT
Ecology from Farm to Fork Of microbial drug Resistance and Transmission- EFFORT- is a EU project that will study the complex epidemiology and ecology of antimicrobial resistance in

animals, the food chain and the environment. EFFORT results will support future evidence based policies, and the prioritization of risk management options along the food chain.
Within this project, real-life intervention studies are conducted in broiler farms with the aim of reducing the use of antimicrobials. A thorough description of the actions taken in each farm, the reasons for their choice, the way they were implemented and their impact, will document the pathways towards antimicrobial reduction. This qualitative information collected during the intervention assay will be synthetized and should help further development of the assessment decision support tool.

AIM OF THE PROJECT

- Implement intervention strategies based on the use of an Assesment Decision Support (ADS) tool and a close follow up of farms by the veterinarian in broiler production.
- Assess the quantitative and qualitative effect of interventions on antimicrobial usage (AMU),, animal health and related economical/technical aspects after implementation of the interventions.
- Refine the ADS tool using qualitative data (reasons for success/failure, acceptability of measures, ...) collected during the intervention study.

PROTOCOL OF THE STUDY

The intervention is aiming at lowering antimicrobial use in broiler farms through actions recommended and close follow-up by the farm veterinarian. It will be based on a preliminary audit of the farm followed by the proposal of an action plan adapted to the farm/farmer. Each farm will then be closely followed by the veterinarian during 2 to 3 years to provide support, adapt the action plan and monitor compliance.

The study design is a MBACI (Multiple Before After Control Intervention) design. Each farm will act as its own control (before/after) and control farms will be included to be able to take into account known underlying trends of antimicrobial use. The evolution of the indicators between the after and before intervention periods will be compared for sites with and without intervention. In the study 60 farms and 60 controls will be included, divided between three intervention areas corresponding to the different countries (Belgium, France and Spain).

DATA COLLECTED

1. Result indicators: Antimicrobial use and technical/economical results
   - retrospective: during the previous year
   - every 3 months during 2 years

2. Risk level indicators: allow measuring intrinsic characteristics that can influence the outcome (main pathology, stress events, climate control, biosecurity), all events that have potentially an impact on e.g. feed consumption, disease occurrence.

Data will be standardised to enable analysis and benchmarking
- antimicrobial use: product type, dose, route of administration, number of treated animals, age, duration of treatment, indication
- performance: technical/economic parameters table 1

Number of chicks (including %) at arrival
Weight of chicks at arrival
Score (definition :)
Deaths in transport boxes
Vaccination 1 at hatchery
Vaccination 2 at hatchery
Duration of empty period (days)
First week (days 1 to 7) mortality (%)
Overall mortality
Netto Feed Conversion Rate
Netto feed conversion rate corrected for 1500g
EPE (European production efficiency)*
Average daily gain (g/d)
Total feed purchased (kg)
Production (kg/m²/batch)
Density (nb / m²)
Departure 1 : mean weight (kg)
Departure 1 : number of animals
Departure 1 : death on arrival at slaughterhouse
Departure 1 : condemnation rate at slaughterhouse :
Departure 2 : mean weight (kg)
Departure 2 : number of animals
Departure 2 : death on arrival at slaughterhouse
Departure 2 : average condemnation rate at slaughterhouse

Table 1: technical and economical parameters

TOOLS

A. Questionnaires

1. Audit questionnaire:

This questionnaire will target potential determinants of pathologies and antimicrobial use/prescription:
- Farm, farmer and staff

- Health management during different periods of the production cycle: first week, middle, last
- Hygiene and biosecurity

The audit results combined with the veterinarian expertise will be the basis for targeting the measures included the action plan.

2. Intervention follow-up questionnaire

The follow-up questionnaire aims at collecting the different indicators (results, compliance, risk factors, competing events).

B. AMU determinants map

The map is an assessment decision support tool to evaluate risk factors and determine an action plan to reduce AMU. It is a visual tool, to help the veterinarians explain/illustrate their recommendations to the farmers. Maps were built based on broad categories of risk factors and determinants for pathologies and high AMU during three periods in the life cycle of the broiler (first week, middle and last).

C. Action plan

The Action plan summarizes the actions recommended by the vet and approved by the farmer, together with the reasons for choosing a particular set of actions (breaks, opportunities) and if pertinent, the reasons for not choosing actions that could have been pertinent.

D. Database

All data from the questionnaires are centralised in one database and analysed. An evaluation will be made of the economic and animal health consequences of intervention strategies to reduce antimicrobial resistance.

E. Tools development

The data collected regarding the success/failures of the different actions taken, the compliance data and the feedback on the reasons for choosing/not choosing the actions will be analysed combined with quantitative results on AMU and performance (i.e. technical and economical results) to refine and develop the tools initially provided to the vets.

Evaluation of the intervention strategies?

To evaluate the impact of an intervention, it is important to obtain objective and standardised data to monitor risk factors and the result parameters: AMU and performance.
Many factors in farm management and biosecurity can be measured: e.g.climate, water and feed quality, cleaning and disinfection.
Health status and vaccination efficacy can be evaluated by laboratory analyses (serology, PCR, bacteriology) and using validated scoring systems e.g quality of day old chicks, lesion scoring for coccidiosis and dysbacteriosis.
These data can be used to follow up the impact of interventions on the farm and to compare between farms.

Expected outcome of EFFORT study

In general, the EFFORT research will provide scientific evidence and high quality data that will inform decision makers, the scientific community and other stakeholders about the consequences of AMR in the food chain, in relation to animal health and welfare, food safety and economic aspects.
More specific, the results of intervention studies in broilers will give information about

the potential economic and animal health consequences of intervention strategies and what are the best interventions to reduce antimicrobial resistance and how they can be prioritised taking into account limited budgets by stakeholders and other constraints and preferences.
In order to maximise intervention strategies chosen, it is important to prioritise the interventions on the basis of their highest impact. At the same time, negative consequences on animal health and welfare need to be prevented, while ensuring the overall quality and productivity of the poultry sector.

CONCLUSIONS

The poultry production is facing new challenges: the consumer demands a good quality product that meets the highest food safety standards. A mayor concern is to reduce antimicrobial resistance in humans, by using less antibiotics in animal production. The EFFORT project will provide scientific evidence and reliable data to develop new tools in veterinary poultry practice to support the decision making process for an optimal treatment or management changes.

A lot of data are available in poultry production: from the farm, the breeder companies, the hatchery, the feed mill, the slaughter house, the diagnostic laboratories, but these data are not analysed and used for benchmarking. This is the new challenge for the poultry vet: to collect accurate and standardised data, analyse these data to detect risk factors and to choose the best intervention strategies to reduce AMU and improve economic results.

This will involve all actors in the poultry chain: the breeding companies to select for birds that have best performance but also good general disease resistance, hatcheries to deliver good quality day old chicks, feed mills to make the best digestible feed, farmers to improve skills to rear the broilers with state of art management , biosecurity, and good internal hygiene protocols. Alternative solutions can be evaluated in an evidence based way and bench marked with other poultry farmers in the same field situation.

This is an opportunity for the poultry veterinarian to take up his role as expert in health advice and support in profitable farm management.

REFERENCE

EFFORT (2014) http://www.effort-against-amr.eu/page/the-effort-project/background-challenges.php.

EPIDEMIOLOGY IN PRACTICE: CAN WE LEARN FROM COMPANION ANIMAL VETERINARIANS?

Dr Dave Brodbelt, Senior Lecturer Companion Animal Epidemiology
Dr Dan O'Neill Companion Animal Epidemiologist
Professor David Church, Vice Principal for Teaching and Learning,
Royal Veterinary College, London

SUMMARY

Electronic patient records (EPR) provide an opportunity to evaluate large scale populations to answer clinically relevant epidemiological questions. The RVC, working with a large group of UK veterinary companion animal practices, collects epidemiological data on diseases seen in practice via their EPR. VetCompass, the Veterinary Companion Animal Surveillance System, shares de-identified clinical health records from over 4 million animals, 11 million episodes of care, within more than 450 practices across the UK in order to evaluate mayor diseases seen in practice, to benefit companion animal health and welfare and increase the evidence base available for vets in practice. This talk will provide an overview of epidemiological opportunities and outputs in small animal practice via experiences gained within VetCompass and explore possibilities to develop similar approaches elsewhere in companion animal and production animal practice.

INTRODUCTION

Effective health surveillance provides information that supports disorder prioritisation, improved disorder management and focussed clinical research to improve animal welfare (Lund et al. 1999). Optimal data sources for companion animal disease surveillance require representativeness of the general population, a well-defined denominator population, validity of disorder diagnosis data and sustainability. Analysis of primary-care practice data benefits from the broad clinical experience of general practitioners to offer unique insights into companion animal health (Faunt et al. 2007) and can support an evidence-based approach that is relevant to primary-care veterinarians (Holmes and Ramey 2007).

An early approach to primary-care practice surveillance (1998–2001) used manual paper-based data collection by veterinary students undergoing extramural studies to describe overall reasons for veterinary presentation and the prevalence of dermatological diagnoses (Hill et al. 2006). This study concluded that, although practicable for short-term and highly focused studies, clinical research using paper-based records was highly labour-intensive and unsustainable for long-term studies.

Electronic recording of clinical data is now increasingly central to human and animal healthcare (Chassin et al. 1998; Adams et al. 1990). International work and now increasingly in the UK has begun to evaluate the potential of such data. In the US, the National Companion Animal Study (NCAS) spanned 1992–1995 and analysed coded clinical data from 31,484 dogs treated at 52 first-opinion clinics (Lund et al. 1999). Clinical diagnostic terms were recorded onto paper by attending clinicians before codification to a standardised nomenclature (developed dynamically during the study) and electronic transfer to a proprietary PMS (Lund et al. 1998). The NCAS studies highlighted the importance to sustainable surveillance of standardised coding, direct recording of electronic data by clinicians, inclusion of all clinical care events and electronic integration between PMSs and research databases.
On a larger scale 800 Banfield Pet Hospitals (www.banfield.com) have generated clinical data on over 2.2 million dogs across 43 states in the USA. Surveillance based on Banfield clinical

data benefits from the use of a single PMS with daily uploads of standardised EPRs to a single computer server (Plant et al. 2011). Collaborative studies using Banfield Pet Hospital data have reported on canine disorders including nematode parasitism, demodicosis, pancreatitis and atopic dermatitis while internal Banfield studies have been published online as 'State of Pet Health' reports.

In the UK a number of initiatives have begun to evaluate EPR for epidemiological studies, including VetCompass, Nottingham University's Centre for Evidence based Veterinary Medicine (CEVM) and Liverpool University's first opinion disease surveillance project, SAVSNET. This presentation will focus on experience gained from work within VetCompass.

MATERIALS AND METHODS

Recent collaborative work across a number of UK veterinary institutions has developed standard veterinary nomenclature (VeNom codes, www.venomcoding org), which has been integrated into a number of practice management systems (PMS) as well as referral hospital EPR, facilitating the collection of coded clinical data. The VeNom codes include standard terminology for reason for visit, presenting complaint, diagnosis and procedure, as well as standard species and breed lists. The VeNom codes have principally focused on small animals, but now an equine draft list has been tested in the RVC Equine Hospital prior to release as a VeNom set of terms and work in farm animals is being explored.

VetCompass builds on the VeNom collaborative initiative and VeNom codes underpin the data collection approach in order to encourage standard data entry in addition to free text clinical note recording. Participating VetCompass practices routinely record their electronic patient records (EPR) and are encouraged to additionally select the most appropriate summary diagnostic term at the end of each episode of care from an embedded list of standard terminology, the VeNom codes. Data relating to each episode of care from participating practices are uploaded to a secure VetCompass SQL database at regular intervals. The data types captured include practice, microchip identification numbers, animal signalment, neutering and insurance status, microchip code, disease diagnosis (VeNom code) and clinical notes, treatments, further tests undertaken, date of death (if applicable) and geographic location (partial postcode). The VetCompass data collection, data management and analytic tools have been validated in peer-reviewed published studies (O'Neill et al. 2012; Fleet et al. 2013, O'Neill et al. 2013, Mattin et al. 2014) and comply with data protection legislation as well as RCVS requirements within the RCVS Guide to Professional Conduct. VetCompass receives funding from a range of charitable foundations including the Kennel Club Charitable Trust, RSPCA, Dogs Trust, Petplan Charitable Trust and RCVS Knowledge as well as governmental funded projects with the Veterinary Medicines Directorate (VMD), and support from scientific boards such as the BBSRC.

RESULTS

VetCompass data collection commenced in 2009 and the current 470 collaborating primary care practices have shared data relating to over 4 million companion animals with more than 11 million unique episodes of care and reflect a wide distribution across the UK (Figure 1).

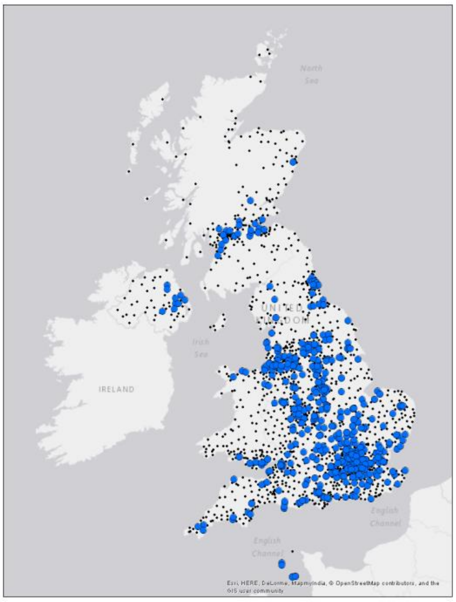

Figure 1 Distribution of current VetCompass practices. Blue dots are participating centres, black dots other RCVS registered clinics currently not collaborating with VetCompass.

Work within VetCompass has evaluated a range of issues related to animal health. Studies have highlighted longevity in dogs and cats (O'Neill et al 2014a and b) as well as overall priorities for diseases in these species (O'Neill et al 2014 c and d, Summers et al. 2015). Other studies have explored the frequency and risk factors specific conditions, as well as survival from diagnosis and spatial distributions of disease (Kersley Fleet et al. 2013, Mattin et al. 2014, 2015, O'Neill et al. 2013, 2015, Stephenson et al. 2014, Summers et al. 2014). Therapeutic studies have been performed including evaluation of NSAID use in practice and antimicrobial use in pyoderma (O'Neill et al. 2012, Summers et al. 2014). More recently antimicrobial usage in practice has been quantified working with the VMD and this is being written up for publication (Buckland et al., in preparation).

DISCUSSION

The use of EPR data provides a valuable resource for epidemiological studies and disease surveillance. Most work has focused on companions animals, but the scope for expanding to other species and countries is immense. The VetCompass programme is being replicated in Australia and projects are also underway in New Zealand and Spain, with other EU countries also considering moving forward with the approach (Denmark, Germany). Translation of the underpinning VeNom codes has been performed for Spanish and German and work on Portuguese is in progress. Work is now also ongoing to expand VetCompass data collection to equine veterinary practices with a pilot project now underway (RVC funded PhD) and future work plans include initiation of a similar approach to production animal practices using 'on farm' herd level data collection.

ACKNOWLEDGEMENTS

VetCompass would like to thank all collaborating practices and groups including Medivet, VetsNow and Vets4Pets/ Companion Care groups as well as all independent practices that take part.

REFERENCES

Chassin MR, Galvin RW (1998) The urgent need to improve health care quality, Institute of Medicine national roundtable on health care quality. JAMA 1998, 280:1000–1005.

Adams VJ et al. (2006) Analysis of a practice management computer software program for owner compliance with recall reminders. The Canadian Veterinary Journal 2006, 47:234–240.

Faunt K et al. (2007) The power of practice, harnessing patient outcomes for clinical decision making. Vet Clin N Am Small Anim Pract 2007, 37:521–532.

Hill PB et al. (2006) Survey of the prevalence, diagnosis and treatment of dermatological conditions in small animals in general practice. Veterinary Record 2006, 158:533–539.

Holmes MA, Ramey DW (2007) An introduction to evidence-based veterinary medicine. Veterinary Clinics of North America, Equine Practice 2007, 23:191–200.

Kersley Fleet et al. (2013). Prevalence and risk factors for canine epilepsy of unknown origin in the UK. Veterinary Record, 172, 338.

Lund EM et al. (1998) PetTerms, a standardized nomenclature for companion animal practice. Online J Veterinary Res 1998, 2:64–86.

Lund EM et al. (1999) Health status and population characteristics of dogs and cats examined at private veterinary practices in the United States. J Am Vet Med Assoc 1999, 214:1336–1341.

Mattin M et al. (2014). An epidemiological study of diabetes mellitus in dogs attending first opinion practice in the UK. Veterinary Record, 174, 349.

Mattin M et al. (2015) Prevalence of and Risk Factors for Degenerative Mitral Valve Disease in Dogs Attending Primary-care Veterinary Practices in England. J Vet Intern Med. 2015 Apr 9. doi: 10.1111/jvim.12591.

O’Neill D et al. (2013). Longevity and mortality of owned dogs in England. The Veterinary Journal, 198, 638-643.

O’Neill D et al. (2013). Chronic kidney disease in dogs in UK veterinary practices: prevalence, risk factors, and survival. Journal of Veterinary Internal Medicine, 27, 814-821.

O’Neill D et al. (2014). Prevalence of disorders recorded in cat attending primary-care veterinary practices in England. The Veterinary Journal, 202, 286-291.

O'Neill DG et al. (2014) Longevity and mortality of cats attending primary care veterinary practices in England. J Feline Med Surg. 2014 Jun 12. pii: 1098612X14536176.

O’Neill D et al. (2014). Prevalence of disorders recorded in dogs attending primary-care veterinary practices in England. PLoS ONE, 9, 1-16.

Plant JD et al. (2011) A case–control study of the risk factors for canine juvenile-onset generalized demodicosis in the USA. Veterinary Dermatology 2011, 22:95–99.

Shoop SJ et al. (2015) Prevalence and risk factors for mast cell tumours in dogs in England. Canine Genetics and Epidemiology 2015, 2:1, doi:10.1186/2052-6687-2-1

Stephens M, et al. (2014) Feline hyperthyroidism reported in primary care veterinary practices in England: prevalence, associated factors and spatial distribution. Veterinary Record. doi: 10.1136/vr.102431

Summers JF et al. (2014) Prescribing practices of primary-care veterinary practitioners in dogs diagnosed with bacterial pyoderma. BMC Vet Res. Oct 8;10(1):240.

Summers JF et al. (2015) Disorders recorded in Cavalier King Charles Spaniels attending primary-care veterinary practices in England. Canine Genetics and Epidemiology. In press.

VETERINARY SYNDROMIC SURVEILLANCE IN BELGIUM: INDICATORS OF IMPORTANCE AND EVALUATION OF ABERRATION DETECTION ALGORITHMS USING HISTORICAL MORTALITY DATA WITH REGARD TO THE 2006-2007 BTV EPIDEMICS

Nijs, H.[1], Koenen, F.[1], Raemaekers, M.[2], Van der Stede, .Y[1], Méroc, E.[1]

1: Veterinary and Agrochemical Research Centre, ERASURV, Groeselenberg 99, B-1180 Brussels, Belgium
2: Federal Agency for the Safety of the Food Chain (FASFC), Kruidtuinlaan 55, B-1000 Brussels, Belgium

INTRODUCTION

Syndromic Surveillance (SyS) gained a lot more attention from both human (HSyS) and veterinary (VSyS) public health authorities in the past decade (Dórea et al., 2011). SyS is defined as the automated (near) real-time monitoring of non-specific health indicators to enable earlier detection of disease outbreaks in animal or human populations than traditional surveillance. The indicators of interest are extracted from datasets with a primary purpose other than SyS, such as: clinical observations from the field (Elbers et al., 2005; Amezcua et al., 2010), milk production records (Madouasse et al., 2013; Madouasse et al., 2014), reproduction parameters (Marceau et al., 2014), abattoir condemnations (Dupuy et al., 2013; Dupuy et al., 2014; Vial and Reist, 2014), mortality rates (Perrin et al., 2010; Perrin et al., 2012; Torres et al., 2015) and laboratory test requests (Gibbens et al., 2008; Dórea et al., 2014a). Datasets of interest are non-specific, meaning that no precise biological agent can be identified as the cause of a disease outbreak by VSyS only. However, it can be concluded that VSyS can be of high added value to already existing specific pathogen targeted surveillance programs.

Recently, a feasibility study on VSyS in Belgium was coordinated by the service ERASURV at the Veterinary and Agrochemical Research Centre (CODA-CERVA) in Brussels, to assess the needs for VSyS and worries within the animal and human public health sector. A questionnaire was designed in which the opinions of stakeholders and experts (S&E's) were considered with regard to important objectives and indicators for a VSyS system. The aims rated highest were (i) the detection of new and emerging diseases, (ii) early outbreak detection in animal populations and (iii) the contribution to human public health surveillance (with regard to zoonoses). Additionally, the most important indicators to be monitored in VSyS were (i) abortion, (ii) mortality, (iii) use of antibiotics, (iv) decrease in milk production and (v) respiratory symptoms (and by extension all clinical indicators) (Nijs et al., 2015 – BELSPO report).

Abortion and mortality were rated amongst the most important indicators for syndromic surveillance by the S&E's. Therefore, weekly historical (2002-2007) cattle and sheep rendering plant (Rendac) data were used with regard to the 2006 and 2007 epidemics of Bluetongue virus serotype 8 (BTV-8) to demonstrate the possibilities of implementation in VSyS. Remarkably, BTV-8 caused clinical symptoms (such as mortality) in both sheep and cattle, whereas previously it was thought that BTV tended to cause subclinical infections in cattle. Méroc et al. (2009) investigated the hypothesis that an increase in mortality rates could possibly be due to the presence of BTV-8 in cattle and small ruminant populations. The same historical mortality dataset was used in this study to evaluate and validate the performance of some of the documented algorithms for VSyS.

MATERIAL AND METHODS

Abortion and mortality data

In this study, a historical dataset from Rendac of weekly abortion and mortality rates of cattle and sheep was assessed and evaluated for implementation in VSyS. The available data contained counts from 2002 up to 2007 and are subdivided in abortion in cattle and mortality according to species and weight category: lambs and adult sheep and abortion, calf and adult bovines. Observations from 2002 to 2005 were used to create a historical, outbreak-free baseline. A Shapiro-Wilks test, performed on all categories, showed significant p-values ($p<0.05$) for all groups, thus implying a low probability of normality in the dataset. Therefore, it was chosen to create a baseline using the nonparametric function based on percentiles. Observations exceeding a 95% CI were considered as outliers, subsequently removed and replaced by the upper limit. A guard band of 2 weeks (that were not implemented in the baseline nor in the detection data) was selected to increase the sensitivity (Se) by ensuring that the data of interest were not contaminated by a significant increase in counts in the last 2 time points. Aberration detection started from week 208, ensuring that counts of the entire years of 2006 and 2007 were available for analysis.

Aberration detection algorithms

Statistical Process Control charts (SPC's) and the Holt-Winters (HW) algorithm were applied to evaluate their performance to detect suspicious aberrations in mortality in 2006 and 2007. The three SPC's used were Shewhart (or X-bar) charts, Exponentially Weighted Moving Averages (EWMA) and Cumulative Sums (CuSum). The SPC's require prior modelling of the data, for which a Poisson general linear model (glm) was used. Temporal effects were accounted for by adding sine, cosine, trend and autoregressive models (AR1 to AR4) to the regression formula. SPC's generate alarms when the predefined thresholds (a multiple of the standard deviation) are exceeded. In the current study the detection limits were fixed at 2.00, 2.25, 2.50, 2.75, 3.00 and 3.50. HW (detection limits set at 95.5%, 96.5%, 97.5%, 98.5% and 99.5% CI) is a data-driven smoother and can account for temporal effects by itself.

Analysis of all data was carried out using RStudio (RStudio Team, 2015) and the package 'vetsyn' (Dórea et al., 2014b) that offers the functions necessary from the pre-processing of raw data to aberration detection and generation and notification of alerts.

RESULTS

Table 1: Abortion

Week	HW	EWMA	Shewhart	CuSum	*Date*
210	A	A	A	A	*03/01/2006*
212		A		A	*17/01/2006*
213				A	*24/01/2006*
216	A		A		*14/02/2006*
220	A				*14/03/2006*
242	A		A	A	*15/08/2006*
243	A			A	*22/08/2006*
244	A	A	A	A	*29/08/2006*
245				A	*05/09/2006*
249	A				*03/10/2006*
259	A	A	A	A	*12/12/2006*
260	A	A	A	A	*19/12/2006*
261	A	A		A	*26/12/2006*
263	A	A	A	A	*09/01/2007*
264	A			A	*16/01/2007*
268	A				*13/02/2007*
269	A				*20/02/2007*
278				A	*24/04/2007*
284		A		A	*05/06/2007*
286		A		A	*19/06/2007*
288		A		A	*03/07/2007*
291		A		A	*24/07/2007*
293		A	A	A	*07/08/2007*
295	A	A	A	A	*21/08/2007*
296	A	A	A	A	*28/08/2007*
297	A	A		A	*04/09/2007*
298	A	A	A	A	*11/09/2007*
299		A		A	*18/09/2007*
300		A		A	*25/09/2007*
301	A	A		A	*02/10/2007*
308	A	A		A	*20/11/2007*
309				A	*27/11/2007*
310				A	*04/12/2007*
311				A	*11/12/2007*

Table 1: Abortion alerts ('A') generated per algorithm

Table 2: Cattle

Week	HW	EWMA	Shewhart	CuSum	*Date*
210	B	C B	C B	C B	*03/01/2006*
219	C		C		*07/03/2006*
220	C			C	*14/03/2006*
226	C				*25/04/2006*
227		B		B	*02/05/2006*
232	B				*06/06/2006*
239	C B	C B	C B	C B	*25/07/2006*
246	C				*12/09/2006*
247	C B				*19/09/2006*
248	C				*26/09/2006*
269	C B				*20/02/2007*
273	B				*20/03/2007*
277	C B		B		*17/04/2007*
282	C		C	C	*22/05/2007*
286	C B				*19/06/2007*
293		C B	C B	C B	*07/08/2007*
295		C	C	C	*21/08/2007*
296	B	C B	B	C B	*28/08/2007*
297		C B		C B	*04/09/2007*
298		C		C	*11/09/2007*
299		C		C	*18/09/2007*
300		C		C	*25/09/2007*
302				C	*09/10/2007*
306	B				*06/11/2007*
308		B		B	*20/11/2007*

Table 2: Mortality alerts for calf ('C') and adult bovine ('B') generated per algorithm

Table 3: Sheep

Week	HW	EWMA	Shewhart	CuSum	*Date*
210	S	S	S	S	*03/01/2006*
213	L				*24/01/2006*
214		L	L	L	*31/01/2006*
215	L	L S	L S	L S	*07/02/2006*
217		L S	L	L	*21/02/2006*
218	L	L	L	L	*28/02/2006*
219	L				*07/03/2006*
220	L				*14/03/2006*
221	L				*21/03/2006*
222	L S				*28/03/2006*
224	L	L	L	L	*11/04/2006*
229	S				*16/05/2006*
231	L	L	L	L	*30/05/2006*
232	L				*06/06/2006*
239	S	S	S	S	*25/07/2006*
243		S			*22/08/2006*
245		S	S	S	*05/09/2006*
246		L S		L S	*12/09/2006*
247		L		L	*19/09/2006*
248		L S		L S	*26/09/2006*
249		L		L S	*03/10/2006*
250	S	S	S	S	*10/10/2006*
251				S	*17/10/2006*
252				S	*24/10/2006*
254	S	S	S	S	*07/11/2006*
268	L S				*13/02/2007*
269	S				*20/02/2007*
270	S				*27/02/2007*
271	L				*06/03/2007*
274	L				*27/03/2007*
275	L				*03/04/2007*
279	S				*01/05/2007*
282	L	S	S	S	*22/05/2007*
286	S		S	S	*19/06/2007*
288	L				*03/07/2007*
289	L S	L	L	L	*10/07/2007*
290				L	*17/07/2007*
291		L	L	L S	*24/07/2007*
292	S	L S	L S	L S	*31/07/2007*
293	L	L S	L S	L S	*07/08/2007*
294	S	L S	S	L S	*14/08/2007*
295	S	L S	L S	L S	*21/08/2007*
296	L S	L S	L S	L S	*28/08/2007*
297	L S	L S	L S	L S	*04/09/2007*
298	L S	L S	L S	L S	*11/09/2007*
299	S	L S		L S	*18/09/2007*
300	S	L S		L S	*25/09/2007*
301	S	L S		L S	*02/10/2007*
302	S	S		S	*09/10/2007*
303		S		S	*16/10/2007*

Table 3: Mortality alerts for lamb ('L') and adult sheep ('S') per algorithm

Thirty four alarm-weeks (aw) were reported for abortion (Table 1), 25 for cattle (Table 2) and 50 for sheep mortality (Table 3). Alerts were generated by the 4 algorithms for all 3 groups in week 210, 296 and 298.

The HW algorithm detected several significant increases in cattle abortion and mortality rates in cattle and sheep, with respectively 20, 16 and 37 aw. During the week of July 25th (2006), clear alarms were triggered for both adult sheep and cattle mortality, after which the algorithm signaled significant increases at multiple weeks from mid-August until the winter of 2007, most distinct in abortion. Alerts were generated in week 286 (19th of June 2007), in both cattle and sheep populations. For the next 2.5 months, the algorithm showed multiple alarms of mortality (mostly in sheep) as well as in abortion.

The Shewhart algorithm generated 11 (abortion), 8 (cattle) and 22 (sheep) aw. Alerts in the first week of 2006 and several alerts from February until April 2006 (lambs) were observed. Distinct increases in mortality in both species in the week of July 25th 2006 were also picked up. Abortion in cattle was flagged as suspicious several times from August 2006 until January 2007.

EWMA (20, 11 and 31 aw for abortion, cattle and sheep) and CuSum (29, 14 and 34 aw) generated alarms in the first week of 2006 and in February and April in sheep. According to both methods, cattle and adult sheep mortality was higher than expected in week 239 (July 25th of 2006). September and the first half of October 2006 were characterized by a rise in sheep mortality (CuSum and EWMA), whereas later on in December, a high number of abortions were observed. In 2007, an increase in abortions was alerted starting in June. The first alarms considering sheep mortality in the summer of 2007 appeared in week 289 (10th of July). Both a high incidence of cattle and sheep mortality as well as the number of abortions generated alarms in the fall of 2007.

DISCUSSION

BTV-8 emerged unexpectedly in Northern Europe in the summer of 2006. The virus was first notified in the Netherlands (17th of August). One day later, also Belgium announced the presence of BTV-8 (Toussaint et al., 2007). A prominent feature in the epidemic was that clinical symptoms, such as mortality, were observed not only in sheep, but also in cattle (Elbers et al., 2008). For BTV-8 affected herds, mortality rates at the time of the first clinical investigation in 2006 were as high as 10% for cattle (Belgium, the Netherlands and France) and 32% for sheep (Belgium and the Netherlands) (Elbers et al., 2008). A German study demonstrated that case-fatality caused by BTV-8 increased in 2007 compared to 2006: 6.4% and 37.5% in infected cattle and sheep herds in 2006 and 13.1% and 41.5% in 2007 (Conraths et al., 2009). The results in the current research confirm the rise in mortality for the second epidemic compared to the first. Aside from clinical disease in animals, also reproductive disorders can be induced by infection with BTV-8 (Dal Pozzo et al., 2009; Saegerman et al., 2011; Nusinovici et al., 2012). Mortality and abortion are also indicators that were rated of high importance for VSyS by S&E's (Nijs et al., 2015 – BELSPO report). Therefore, both indicators were used to evaluate and validate several aberration detection algorithms.

The applied algorithms have different characteristics and detect different types of outbreaks. Shewhart charts are the most elementary SPC's: only the last previous time point is taken into account for the analysis. Therefore, the Shewhart algorithm will signal an alert faster when there is a sudden, distinct increase in case counts (Dórea et al, 2013). While for Shewhart charts, aberration detection is only based on the previous time point, the CuSum method makes calculations based on the standardized differences of all previous time points. These differences between observed and expected standard deviations are summed: when the predefined threshold is exceeded, an alarm is generated. A more complex method but comparable to CuSum, is EWMA. In this particular approach, a weighting parameter (lambda) is added into the equation. Weighting is applied to attach more importance to values from recent time points than those further removed in time. HW is no SPC method but a data-driven smoother, originally used for forecasting. Contrary to SPC's, no pre-processing is required to eliminate temporal effects: HW can account for these difficulties by itself. Also, detection is not based on a multiple of standard deviations, but on a set confidence interval (CI) (Dórea et al., 2013). All 4 methods are able to detect increases in mortality.

The fact that the algorithms generate alarms during both outbreaks in 2006 and 2007 proves that SPC and HW methods can be used to detect suspicious increases in mortality incidence. In this study, the Shewhart algorithms generated less alarms compared to the other methods. This could be explained by the capability of the Shewhart charts to detect sudden increases faster, but its Se is lower for slow rising outbreaks (Dórea et al., 2013). This implies that at the time points that the Shewhart methods generated alarms, there was a big difference between the observed and expected case counts. On the contrary, CuSum (based on the accumulation of differences in the standard deviation and thus best fit to detect flat outbreaks) and EWMA can be used to detect slow changes in case counts (Dórea et al., 2013). Another algorithm that is applied mostly for the detection of slow, exponential and lognormal shaped outbreaks is HW. The results imply that for weeks where all 4 algorithms generated alarms (such as week 210), mortality and abortion counts were probably already increasing gradually in the weeks preceding the alert, leading up to detection by CuSum, EWMA and HW. An (additional) sudden increase led to alarms being triggered also by the Shewhart algorithm. Additionally, alarms were also triggered prior to the official notification of BTV-8: approximately 3 weeks to 1 month before notification in 2006 in both cattle and sheep mortality and 2007 for adult sheep only. Elbers et al. (2008) reported reproductive disorders as a clinical sign of BTV-8 infection. The results of this study indicate that SPC's and HW detected suspicious increases in cattle abortion, cattle and sheep mortality in the fall and winter of 2006 and also in the late summer of 2006 and 2007. This corresponds with the clinical observations from the BTV-8 epidemics in 2006 and 2007 and thus it can be concluded that SPC's and HW can be applied for the purpose of VSyS. However, these observations are no solid proof of the impact of the BTV-8 virus as only these non-specific indicators were analyzed and no concrete data on BTV outbreaks in Belgium were implemented in this study. Because outbreaks of different diseases are characterized by various speeds and characteristics of spread, the results from this study cannot automatically be extrapolated to other diseases or syndromes.

REFERENCES

Amezcua M. d. R., Pearl D. L., Friendship R. M., McNab W. B. (2010). Evaluation of a veterinary-based syndromic surveillance system implemented for swine. Can. J. Vet. Res. 74, 241-251.

Conraths F. J., Gethmann J. M., Staubach C., Mettenleiter T. C., Beer M., Hoffman B. (2009). Epidemiology of bluetongue virus serotype 8, Germany. Emerging Infectious Diseases. Vol 15, No. 3.

Dal Pozzo F., Saegerman C., Thiry E. (2009). Bovine infection with bluetongue virus with special emphasis on European serotype 8. The Vet. Journal 182, 142-151.

Dórea F. C., Lindberg A., McEwen B. J., Revie C. W., Sanchez J. (2014a). Syndromic surveillance using laboratory test requests: a practical guide informed by experience with two systems. Prev. Vet. Med. 116, 313-324.

Dórea F. C., McEwen B. J., McNab W. B., Revie C. W., Sanchez J. (2013). Syndromic surveillance using veterinary laboratory data: data pre-processing and algorithm performance evaluation. J. R. Soc. Interface 10: 20130114.

Dórea F. C., Widgrén S., Lindberg A. (2014b). Vetsyn: veterinary syndromic surveillance streamlined into one R package. ISDS Annual Conference Proceedings 2014.

Dupuy C., Demont P., Ducrot C., Calavas D., Gay E. (2014). Factors associated with offal, partial and whole carcass condemnation in ten French cattle slaughterhouses. Meat Science 97, 262-269.

Dupuy C., Morignat E., Maugey X., Vinar J.-L., Hendrikx P., Ducrot C., Calavas D., Gay E. (2013). Defining syndromes using cattle meat inspection data for syndromic surveillance purposes: a statistical approach with the 2005-2010 data from ten French slaughterhouses. BMC Vet. Research 9: 88.

Elbers A. R. W., Backx A., Méroc E., Gerbier G., Staubach C., Hendrickx G., van der Spek A., Mintiens K. (2008). Field observations during the bluetongue serotype 8 epidemic in 2006 I. Detection of first outbreaks and clinical signs in sheep and cattle in Belgium, France and the Netherlands. Prev. Vet. Med. 87, 21-30.

Elbers A. R. W., Koch G., Bouma A. (2005). Performance of clinical signs in poultry for the detection of outbreaks during the avian influenza A (H7N7) epidemic in the Netherlands in 2003. Avian Pathology, 34:3, 181-187.

Gibbens J. C., Robertson S., Willmington J., Milnes A., Ryan J. B. M., Wilesmith J. W., Cook A. J. C., David G. P. (2008). Use of laboratory data to reduce the time taken to detect new diseases: VIDA to FarmFile. Vet. Rec. 162, 771-776.

Madouasse A., Marceau A., Lehébel A., Brouwer-Middelesch H., van Schaik G., Van der Stede Y., Fourichon C. (2013). Evaluation of a continuous indicator for syndromic surveillance through simulation. Application to vector borne disease emergence detection in cattle using milk yield. PLoS One, 8(9): e73726.

Madouasse A., Marceau A., Lehébel A., Brouwer-Middelesch H., van Schaik G., Van der Stede Y., Fourichon C. (2014). Use of monthly collected milk yields for the detection of the emergence of the 2007 French BTV epizootic. Preventive Veterinaty Medicine 113, 484-491.

Marceau A., Madouasse A., Lehébel A., van Schaik G., Veldhuis A., Van der Stede Y., Fourichon C. (2014). Can routinely recorded reproductive events be used as indicators of disease emergence in dairy cattle? An evaluation of 5 indicators during the emergence of bluetongue virus in France in 2007 and 2008. J. Dairy Sci. 97: 6135-6150.

Méroc E., Herr C., Verheyden B., Hooyberghs J., Houdart P., Raemaekers M., Vandenbussche F., De Clercq K., Mintiens K. (2009). Bluetongue in Belgium: episode II. Transboundary and Emerging Diseases, 56, 39-48.

Nijs H., Koenen F., Van der Stede Y., Méroc E. (2015). Haalbaarheidsstudie naar veterinaire syndromic surveillance (VSS) in België (SYS.BE). Project report.

Nusinovici S., Seegers H., Joly A., Beaudeau F., Fourichon C. (2012). Increase in the occurrence of abortions associated with exposure to the bluetongue virus serotype 8 in naïve dairy herds. Theriogenology 78, 1140-1151.

Perrin J.-B., Ducrot C., Vinard J.-L., Morignat E., Calavas D., Hendrikx P. (2012). Assessment of the utility of routinely collected cattle census and disposal data for syndromic surveillance. Prev. Vet. Med. 105, 244-252.

Perrin J.-B., Ducrot C., Vinard J.-L., Morignat E., Gauffier A., Calavas D., Hendrikx P. (2010). Using the national cattle register to estimate the excess mortality during an epidemic: application to an outbreak of bluetongue serotype 8. Epidemics 2, 207-214.

RStudio Team. (2015). RStudio: Integrated Development for R. RStudio, Inc., Boston, MA URL http://www.rstudio.com/.

Saegerman C., Bolkaerts B., Baricalla C., Raes M., Wiggers L., de Leeuw I., Vandenbussche F., Zimmer J.-Y., Haubruge E., Cassart D., De Clercq K., Kirschvink N. (2011). The impact of naturally-occurring, trans-placental bluetongue virus serotype-8 infection on reproductive performance in sheep. The Vet. Journal 187, 72-80.

Torres G., Ciaravino V., Ascaso S., Flores V., Romero L., Simón F. (2015). Syndromic surveillance system based on near real-time cattle mortality monitoring. Prev. Vet. Med. 119, 216-221.

Toussaint J.-F., Sailleau C., Mast J., Houdart P., Czaplicki G., Demeestere L., Vandenbussche F., van Dessel W., Goris N., Bréard E., Bounaadja L., Thiry E., Zientara S., De Clercq K. (2007). Bluetongue in Belgium, 2006. Emerging Infectious Diseases. Vol 13, No. 4.

Vial F., Reist M. (2014). Evaluation of Swiss slaughterhouse data for integration in a syndromic surveillance system. BMC Vet. Research, 10:33.

De Vries A., Reneau J. K. (2010). Application of statistical process control charts to monitor changes in animal production systems. J. Anim. Sci. 2010, 88:E11-E24.

Doréa F.C., Sanchez J., Revie C.W. (2011). Veterinary syndromic surveillance: Current initiatives and potential for development. Preventive Veterinary Medicine 101, 1-17.

A DESCRIPTIVE STUDY TO ASSESS THE PERCEPTION OF CATTLE FARMERS TOWARDS THE IMPLEMENTATION OF BIOSECURITY

Sarrazin Steven[1], Heremans Evelien[1],, Dewulf Jeroen[1]*
[1]Veterinary Epidemiology Unit, Department of Reproduction, Obstetrics and Herd Health, Faculty of Veterinary Medicine, Ghent University, Salisburylaan 133, 9820 Merelbeke, Belgium
**Currently working in veterinary practice*

INTRODUCTION

The shift from cure towards prevention in veterinary medicine involves the implementation of biosecurity, which includes all measures preventing pathogens from entering a herd and reducing the spread of pathogens within a herd (Lin et al., 2003; Villarroel et al., 2007; Derks et al., 2013; Laanen et al., 2013). In a recent study it was shown that that few biosecurity measures were undertaken by Belgian cattle farmers, thereby exposing themselves to the risk of disease transmission within and between farms (Sarrazin et al., 2014). Although basic biosecurity measures such as farm-specific protective clothing and boots are present in the majority of the farms, they appear to be insufficiently or incorrectly used. These findings raised questions about the reasons behind the limited implementation of biosecurity measures. Therefore the aim of this study was to assess the perception of cattle farmers towards the implementation of biosecurity.

MATERIAL AND METHODS

The study consisted of a qualitative part in the form of a focus group and a quantitative part in the form of a questionnaire. Eight female Flemish cattle farmers participated in the focus group discussion, during which several topics concerning the implementation of biosecurity on cattle farms were discussed. The results of the focus group were analysed by summarizing trends across the topics that were discussed. Based on the results of the focus group a questionnaire with 18 semi-closed (13 questions with a 5-level Likert scale) and 5 open questions was developed and conducted face-to-face during the fair for Flemish agriculture (Agriflanders) in January 2015. The results of the questionnaire were analysed using basic descriptive analysis in Microsoft Excel and SPSS.

RESULTS

Focus group discussion

Four of the participants were dairy farmers, while one was a beef farmer and three had both dairy and beef cattle. When the concept of biosecurity was explained, they assessed the term as ‘misleading’ (“‘bio’ refers to biological agriculture”), too ‘difficult’ and ‘frightening’. Furthermore, they felt ‘no involvement’ with the term. Nonetheless, they were convinced that biosecurity can help in obtaining more healthy animals and less veterinary costs, but mentioned more administration, more rules and inspection the possible time-consuming aspect (“we love our job, but don’t practice it for fun”) as possible disadvantages.

The group was reluctant to ask professional visitors (herd veterinarian, artificial insemination technician, cattle salesman) to use herd specific clothing. A first reason for this was that since veterinarians have a higher education, they should propose themselves to use herd specific clothing. Secondly, they believe it is hypocritical to demand to use herd specific clothing to visitors, while the farmers themselves do not implement a specific biosecurity measure (e.g. quarantining cattle returning from a fair).

When discussing possible way to improve the implementation of biosecurity in cattle farms, the group stressed the urgent need for additional practical and persistent support and information. The preferred way to obtain this information is through the herd veterinarian. However, the group remarked that their herd veterinarian has very little time to give preventive advice ("Our veterinarian is able to solve problems, but is not able yet to prevent them"). Furthermore, it is not clear whether there should be paid for veterinary preventive advice ("I would be happy to receive information during the caesarean section").

Questionnaire results

Ninety-one face-to-face interviews (25% dairy farmers, 43% beef and 32% mixed) were conducted (Table 1). All respondents originated from Flanders and the majority were male (88%).

Table 1. Questionnaire results for 13 semi-closed questions with a 5-level Likert scale (*n*=91)

Question	Likert scale[a]				
	1	2	3	4	5
I am familiar with the term 'biosecurity'	8[b]	34	25	32	1
I am familiar with the term 'animal disease prevention'	0	1	8	85	7
The term 'biosecurity' is correct term for the concept (after explanation of the concept)	9	41	11	40	0
The term 'biosecurity' scares me off	1	40	15	43	1
As a farmer I feel responsible for 'biosecurity'	0	4	9	79	8
As a farmer I believe that 'biosecurity' costs me more money than it raises	1	59	20	18	2
As farmer I believe that 'biosecurity' costs me more time and effort than it raises	0	52	17	32	0
I have sufficient information to apply 'biosecurity' well in practice	1	29	19	51	1
I am willing to pay for veterinary advice on 'biosecurity'/'animal disease prevention'	1	44	28	26	1
As a cattle farmer it is more difficult to apply biosecurity well than as pig/poultry farmer	1	39	13	44	3
I dare to demand visitors to use herd specific clothing	0	19	14	60	7
A quarantine period of 3 weeks cannot be obtained on my farm	6	22	13	45	13
I believe that the level of 'biosecurity' can be improved on my farm	0	8	12	79	1

[a]1 = Strongly disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; 5 = Strongly agree

[b]Due to rounding the percentages may not exactly sum up to 100%

Although Flemish cattle farmers are familiar with several specific biosecurity measures, such as quarantine and the use of herd-specific clothing, they associate these measures with 'disease prevention' rather than with the term 'biosecurity'. They tend to relate this term to food safety (23%) and ecological farming (21%) or have no idea what this concept is about (48%). Fourty-one percent of the farmers feels threatened by the term and half of the respondents prefers another term for the concept. The majority of the farmers (87%) feels responsible for the implementation of biosecurity on their farm and 52% of the respondents to the questionnaire indicates to have sufficient information to implement biosecurity adequately. Nearly all farmers (98%) identified their herd veterinarian as the main source of this information. Furthermore, only 45% of the farmers is willing to pay their herd veterinarian for such preventive advice and 47% believes that it is more difficult to implement biosecurity for cattle farmers than for pig and poultry farmers. Cited reasons for this are for instance the fact that cattle are pastured (30%) and cattle farms are more often visited (13%). Nonetheless, only 20% and 32% of the respondents is convinced that the implementation of biosecurity will cost them money and will require more time and effort, respectively. Finally, 80% sees room for improvement of the biosecurity level in their herd, such as quarantining purchased cattle, disinfection and herd specific clothing.

DISCUSSION

In this study quantitative (questionnaire) and qualitative (focus group) research were combined to describe possible thresholds for a good implementation of biosecurity measures in cattle farms from a farmers' point of view. Quantitative research is frequently used in veterinary medicine, while qualitative research is often criticized for not having enough scientific rigour (Krefting, 1990). Although it is not an assumption in qualitative research that the participants are representative for the population, the obtained results can very useful in better understanding the issues concerning the subject (Christley and Perkins, 2010).

Despite the current low implementation of biosecurity measures in Flemish cattle herds (Sarrazin et al., 2014), this study showed that farmers feel responsible for the improvement of the biosecurity level in their herd. Although extensive information concerning biosecurity may currently be available, farmers do not associate disease prevention with 'biosecurity' and indicate the need of more information on the level of the farmers themselves in a practical manner. As already described in previous studies (Gunn et al., 2008; Heffernan et al., 2008; Brennan and Christley, 2013; Laanen et al., 2014) and confirmed in this study, farmers believe their herd veterinarian should be their main source of information. However, they are reluctant to pay for this information and raise a lack of time of the herd veterinarian as barrier. By analogy with pigs and poultry, in a first step farmers could be provided with accessible and practical information through a biosecurity testing tool to explain the concept of biosecurity and to increase their awareness (www.BioCheck.UGent.be; Laanen et al., 2010; Gelaude et al., 2014). Secondly, a preventive strategy could be developed in collaboration with the herd veterinarian who knows the herd structure and can inform the farmer on the critical points for that specific farm (Villarroel et al., 2007; Ellis-Iversen et al., 2010; Brennan and Christley, 2013). The ultimate goal should be to consider biosecurity a collective responsibility, with farmers taking initiative to improve their biosecurity level and herd veterinarians as coaches, rather than an individual responsibility.

ACKNOWLEDGEMENTS

The authors wish to thank Dierengezondheidszorg Vlaanderen (DGZ) for the possibility to question the farmers during the fair for Flemish agriculture (Agriflanders) and the cattle farmers for participating the study.

REFERENCES

Brennan, M.L., Christley, R.M., 2013. Cattle producers' perceptions of biosecurity. BMC Vet. Res. 9, 71.

Christley R.M., Perkins E., 2010. Researching hard to reach areas of knowledge: Qualitative research in veterinary science. Equine Vet. J. 42, 285-286.

Derks, M., van Werven, T., Hogeveen, H., Kremer, W.D.J., 2013. Veterinary herd health management programs on dairy farms in the Netherlands: Use, execution, and relations to farmer characteristics. J. Dairy Sci. 96, 1623-1637.

Ellis-Iversen, J., Cook, A.J.C., Watson, E., Nielen, M., Larkin, L., Wooldridge, M., Hogeveen, H., 2010. Perceptions, circumstances and motivators that influence implementation of zoonotic control programs on cattle farms. Prev. Vet. Med. 93, 276-285.

Gelaude, P., Schlepers, M., Verlinden, M., Laanen, M., Dewulf, J., 2014. Biocheck.UGent: A quantitative tool to measure biosecurity at broiler farms and the relationship with technical performances and antimicrobial use. Poult. Sci. doi: 10.3382/ps.2014-04002

Gunn, G.J., Heffernan, C., Hall, M., McLeod, A., Hovi, M., 2008. Measuring and comparing constraints to improved biosecurity amongst GB farmers, veterinarians and the auxiliary industries. Prev. Vet. Med. 84, 310-323.

Heffernan, C., Nielsen, L., Thomson, K., Gunn, G., 2008. An exploration of the drivers to bio-security collective action among a sample of UK cattle and sheep farmers. Prev. Vet. Med. 87, 358-372.

Krefting L., 1990. Rigor in qualitative research: the assessment of trustworthiness. Am. J. Occup. Ther. 45, 214-222.

Laanen, M., Beek, J., Ribbens, S., Vangroenweghe, F., Maes, D., Dewulf, J., 2010. Biosecurity on pig herds: development of an on-line scoring system and the results of the first 99 participating herds. Vlaams Diergeneeskundig Tijdschrift 79, 302-306.

Laanen, M., Persoons, D., Ribbens, S., de Jong, E., Callens, B., Strubbe, M., Maes, D., Dewulf, J., 2013. Relationship between biosecurity and production/antimicrobial treatment characteristics in pig herds. Vet. J. 198, 508-512.

Laanen, M., Maes, D., Hendriksen, C., Gelaude, P., De Vliegher, S., Rosseel, Y., Dewulf, J., 2014. Pig, cattle and poultry farmers with a known interest in research have comparable perspectives on disease prevention and on-farm biosecurity. Prev. Vet. Med. 115, 1-9.

Lin, J.H., Kaphle, K., Wu, L.S., Yang, N.Y.J., Lu, G., Yu, C., Yamada, H., Rogers, P.A.M., 2003. Sustainable veterinary medicine for the new era. Rev. Sci. Tech. OIE 22, 949-964.

Sarrazin S., Cay A.B., Laureyns J., Dewulf J., 2014. A survey on biosecurity and management practices in selected Belgian cattle farms. Preventive Veterinary Medicine 117, 129-139.

Villarroel, A., Dargatz, D.A., Lane, V.M., McCluskey, B.J., Salman, M.D., 2007. Suggested outline of potential critical control points for biosecurity and biocontainment on large dairy farms. J. Am. Vet. Med. Assoc. 230, 808-819.

SURVEILLANCE OF BOVINE TUBERCULOSIS: APPROACH TOWARDS BENCHMARKING AT SLAUGHTERHOUSE AND DURING PURCHASE TESTING

Welby, S., Fretin, D., Roupie, V., Van der Stede, Y.*
**CODA-CERVA, Groeselenberg 99, 1180 Brussels Belgium*
Unit of Epidemiology, Risk Analysis and Surveillance (ERASURV) & Unit of Bacteriology

INTRODUCTION

Bovine Tuberculosis (bTB), due to the causative agent *Mycobacterium bovis*, is of increasing concern across many European Union (EU) Member States. Following a successful eradication campaign and following a constant decrease of the total number of cases since the end of the nineties, Belgium obtained the officially bTB free status in 2003 (Decision 2003/467/CE), meaning in other words that for 6 consecutive years, 99.9% of the cattle herd population tested negative and that herd prevalence was below 0.1% (Directive 64/432/CEE). The main bTB surveillance pillars in BE consist of, as a first line screening surveillance, visual inspection at slaughterhouse and single intradermal tuberculin test (SIT) of all cattle above 6 weeks of age during purchase. Yearly testing of dairy herds with on farm delivery, imported cattle from non-officially free countries (for 3 consecutive years) are screened via SIT during the winter. Once a breakdown is detected, a thorough tracing-on and tracing-back investigation of all contact herds is carried out and these contact herds are screened yearly for 5 consecutive years during the winter. Despite efforts made over the last decade to eradicate the disease, Tuberculosis is currently re-emerging in some of our neighbouring countries making surveillance and control of bovine tuberculosis a constant challenge worldwide. Many reasons have been put forward to explain this re-emergence: globalisation, trade, wildlife reservoir, environmental reservoir, and imports from non-official free countries, social behaviour, etc. (Humblet et al., 2009; Schiller et al., 2010). In Belgium, a few sporadic cases can be detected yearly, but because these are rapidly eradicated and under control the official free status is maintained.

For Member States with an officially free status, one of the main concerns is to make sure surveillance is effective enough to early detect possible new infections in order to maintain this ‘free-status’. In addition, due to the imperfect sensitivity and specificity of the diagnostic test, even in disease freedom situation, positive reactors are expected; of which most of them will be confirmed as false positive if the country is truly free of disease. The aim of this study was to investigate the number of true and false positive reactors that could be expected, given predefined minimal design prevalence, the diagnostic tests characteristics of the intra dermal tuberculin skin test at purchase and the post mortem visual inspection at slaughter house. The generated results could provide insight about the efficacy of the current surveillance system.

MATERIAL & METHODS

All active cattle movements in 2013 (purchases, imports, birth, and slaughter) were extracted from our National Animal Registration and Identification data base (Sanitel). For each individual movement, the following records were obtained: ID cattle, ID herd of origin, ID herd of destination, birth date, movement date, movement type (purchase, import, export, slaughter, market), cattle type1 (fattening calves (FC) versus bovine), cattle type2 (Mixed, Meat, Dairy). Based on the official predefined maximum tolerable design prevalence at herd level (Directive 64/432/CEE) and simulated prevalence at animal level, the test characteristics (sensitivity and specificity) of the intradermal skin test at purchase and visual post-mortem inspection in the slaughter house (EFSA, 2012), the proportions of cattle processed in each component, the expected positive reactions (true positive + false positive) in the different defined populations strata were computed. Data management was carried out in SAS 9.2 and the stochastic simulation model was run in ModelRisk 3.0, with 10 000 iterations per simulation, taking into account all factors affecting variability and or uncertainty.

RESULTS

Movement, birth, slaughter records from the 2700000 active cattle originating from the 28500 active Belgian herds in 2013 were obtained from SANITEL. Considering that fattening calves are not tested at purchase the study focused only on the other category of cattle for which purchase testing and visual inspection is mandatory. In such a way, it was considered that 450 000 (~60%) of the total slaughtered and around 345 000 (~50%) out of the total purchased cattle were presumably inspected or tested annually. Taking into account the sensitivity and specificity of the visual inspection at slaughterhouse and intra dermal tuberculin test during purchase, different simulated animal prevalence (1/1000; 1/10000; 1/100000 infected) the expected number of true and false positive reactors were estimated. The output was modelled as a distribution of possible outcomes with values ranging between minimum, maximum, mean and percentiles (0-100 percentiles). As an example, table 1, displays the minimum, maximum, mean expected reaction rate in the different surveillance components considering 0.01% prevalence (1/10000).

Table 1: Range of expected false and true positive reactions rate during purchase and at slaughterhouse.

Expected prevalence (animal level)	Expected positive reaction rate	False positive		True positive	
		Purchase	Slaughterhouse	Purchase	Slaughterhouse
0.01%	Minimum	0.02712%	0.00000%	0.00064%	0.00058%
	Mean	1.31266%	0.02504%	0.00105%	0.00104%
	Maximum	3.51198%	0.12532%	0.00120%	0.00138%

If we were to consider for benchmarking purpose, that it is reasonable to expect, amongst the cattle tested or inspected, an annual positive reactor rate between the 25 and 75 percentile of the present iteration study, it would mean that 45 and 180 suspected lesions of annual slaughtered cattle should be expected to be sent for further investigation, and between 2 500 and 6000 of all tuberculin tested bovines at purchase should react positively. Out of these reactors 99.99% would be false positive reactors if the expected design prevalence remains low around 0.01% (minimum of 1 out of 10^4 is infected).

DISCUSSION

The simulations provide useful insight about the minimal expected positive reactors during visual inspection at slaughterhouse and the intradermal tuberculin testing at purchase. Data regarding diagnostic tests characteristics for bTB from the EFSA review 2012 (EFSA, 2012), maximum tolerable prevalence at herd level, different simulated animal design prevalence and movement data from the Belgian cattle population were used to feed this model. It could be argued that diagnostic test values might not be applicable to the Belgian field data. Indeed previous studies carried out by Humblet et al. (2011) and Welby et al, (2012) showed that intradermal skin test during purchase was not always performed out is according to GVP (good veterinary practice). Due to the stochastic nature of the present study, results were reflecting these biases linked to the variability and uncertainty of the diagnostic testing procedure. This was further corroborated by recent published data on sensitivity and specificity of these tests performed in other countries and using historical data in Belgium (Schiller et al, 2010; Bézos et al., 2014). The study did not take into account fattening calves, because to date these are not tested in Belgian. However our studies and observed historical data indicate that it could provide valuable information in order to speed up detection to test these fattening calves. Interestingly, the expected animal design prevalence (0.1, 0.01 and 0.001%) had only a very small impact on the expected false positive reactors. This can be explained by the fact that the design prevalence mainly affects the true positive reaction rate while the false positive reaction rate is mainly driven by the specificity characteristics of diagnostic test.

Results of this study raises the issues related to more sensitive tests. The major causes of bTB re-mergence or persistence is wild life reservoirs, larger herd sizes, increased animal movements, limitations of control (partial herd depopulation versus whole herd) but also limitations of diagnostic tests. Furthermore, Tuberculosis counting for a large proportion of the countries expenditure implicitly triggers the need of having an effective and efficient surveillance program. Traditional testing schemes relied mainly on herd testing; thereby the limited sensitivity at individual testing was compensated by the large number of animals tested. To date new tests have emerged, but the need to validate these tests in the field is required. Nevertheless, the present study provides useful insight for the current official testing schemes applied worldwide and could be used for benchmarking surveillance and possibility increase disease awareness in the correct application of current and future diagnostic protocols. In addition, the methodology applied in the present study revealed a useful tool for evaluating efficacy of surveillance in accordance with the objectives prescribed by the European and International standards.

REFERENCES

Bezos J, Casal C, Romero B, Schroeder B, Hardegger R, Raeber AJ, López L, Rueda P, Domínguez L , 2014. Current ante-mortem techniques for diagnosis of bovine tuberculosis. Res Vet Sci. 97 Suppl:44-52

EFSA (European Food Safety Authority) Panel on Animal Health and Welfare (AHAW), 2012. Scientific Opinion on the use of a gamma interferon test for the diagnosis of bovine tuberculosis. EFSA Journal 10(12): 13

EU (European Union), 1964. Council Directive of 26 June 1964 on animal health problems affecting intra-Community trade in bovine animals and swine 64/432/EEC. Official Journal 121: 1977

EU (European Union), 2003. Commission Decision of 23 June 2003 establishing the official tuberculosis, brucellosis, and enzootic bovine leucosis free status of certain Member States and regions of Member States as regards bovine herds 2003/467/EC. Official Journal L 156: 74

Humblet MF, Boschiroli ML, Saegerman C, 2009. Classification of worldwide bovine tuberculosis risk factors in cattle: a stratified approach. Vet Res. 40(5): 50.

Humblet MF, Walravens K, Salandre O, Boschiroli ML, Gilbert M, Berkvens D, Fauville-Dufaux M, Godfroid J, Dufey J, Raskin A, Vanholme L, Saegerman C, 2011. Monitoring of the intra-dermal tuberculosis skin test performed by Belgian field practitioners. Research in Veterinary Science 91: 199–207

Moniteur belge, 2003. Arrêté royal du 17 Octobre 2002 relatif à la lutte contre la tuberculose bovine. Moniteur Belge 2003022000 : 12448

Schiller I, Oesch B, Vordermeier HM, Palmer MV, Harris BN, Orloski KA, Buddle BM, Thacker TC, Lyashchenko KP, Waters WR, 2010. Bovine tuberculosis: a review of current and emerging diagnostic techniques in view of their relevance for disease control and eradication. Transbound. Emerg. Dis. 57(4):205-20.

Welby S, Govaerts M, Vanholme L, Hooyberghs J, Mennens K, Maes L, Van Der Stede Y, 2012. Bovine tuberculosis surveillance alternatives in Belgium..Prev Vet Med. 106(2):152-61.

ANTIMICROBIAL USE AND BIOSECURITY PRACTICES IN PIG PRODUCTION IN FOUR EUROPEAN COUNTRIES, COMPARISON, ASSOCIATIONS AND OPPORTUNITIES.

Dewulf, J., Backhans, A., Collineau, L., Loesken, S., Postma, M., Sjölund, M., Okholm Nielsen, E., Belloc, C., Emanuelson, U., Grosse Beilage, E. & Stärk, K.D.C

ABSTRACT

We studied the antimicrobial use in 227 pig herds originating from 4 European countries (Belgium, France, Germany, Sweden) and its association with animal health, production, biosecurity and other disease prevention measures.

Huge differences in antimicrobial use, ranging from excessively high to remarkably low, were observed within and between countries with an average treatment incidence from birth till slaughter of 243 in Germany (42 for the sows), in Belgium 143 (16 for sows), in France 108 (22 for sows) and in Sweden 23 (11 for sows). As the biosecurity is concerned, Sweden had on average the highest total biosecurity status (63.7), followed by Germany (63.0), France (58.6) and Belgium (57.8) In all countries external biosecurity (measures taken to prevent disease introduction) scored higher compared to internal biosecurity (measures taken to prevent within herd disease transmission) which has been observed in previous studies.

It was found that antimicrobial usage in sows was significantly associated with the antimicrobial usage from birth till slaughter in the growers, the use of anti-inflammatory products in weaners and the number of pathogens vaccinated against, suggesting an overall higher disease pressure. Higher antimicrobial usage from birth till slaughter was associated with a shorter farrowing rhythm and a younger weaning age, whereas a better external biosecurity was related with a lower antimicrobial usage. A higher external biosecurity was associated with more weaned piglets per sow per year. Based upon the available data “44 top farmers” were identified that managed to combine both below national average usage of antimicrobials and above national average technical performances. These farmers were characterized by an on average higher internal biosecurity status and were generally located in a more favorable environment (lower pig density and limited contact with wildlife). They also treated less frequently against respiratory clinical symptoms in weaners and finishers.

Overall the study showed high variation both in antimicrobial usage, biosecurity and management practices indicating substantial room for improvement. Moreover some cross country associations were identified allowing for potential interventions such as using a longer farrowing rhythm, weaning of the piglets at an older age and improvement of the biosecurity status. At the same time, the improved biosecurity is expected to result in improve technical performances.

INTRODUCTION

The global development and spread of antimicrobial resistance is largely driven by the extensive use of antimicrobials both in human and animal medicine. In a recent study, data on sales of antimicrobials for food-producing animals were compared to data on antimicrobial resistance, and a clear association between use and resistance was found (Chantiziaris et al., 2013). The ESVAC reports have shown that there are vast differences between countries in amounts of antimicrobials sold for food-producing animals (Esvac 2012, grave et al., 2014), but these data do not provide insight on how sales are distributed by species and age groups.

Within livestock production, pig husbandry has been identified as one of the main consumers of antimicrobials (Fillipitzi et al., 2014). To allow for the development of plans for antimicrobial usages reduction, first a detailed understanding of the current use and its associations with animal health and production characteristics is required. Limited knowledge is currently available about the main drivers for antimicrobial usage as well as the farmers' perceptions, attitudes and behaviors regarding antimicrobial usage and resistance. To this extend we studied the antimicrobial use in pig herds originating from 4 European countries (Belgium, France, Germany, Sweden) and its association with animal health, production, biosecurity and other disease prevention measures.

MATERIAL & METHODS,

Data were collected between December 2012 and December 2013 in a cross-sectional study in 227 farrow-to-finish pig herds with at least 100 sows and 500 finishing pigs in Belgium (n = 47), France (n = 60), Germany (n = 60) and Sweden (n = 60). In Belgium, were recruited among those subscribing to a professional newsletter regularly issued by the University of Ghent. In France, herds were randomly selected from the Northwestern region among those registered in a technical database maintained by the French Institute for pig and pork industry (IFIP). German herds were recruited via consultancy circles together with contacts provided by several veterinary practices in the three regions, Mecklenburg-Vorpommern, Niedersachsen and Nordrhein-Westfalen. Swedish herds were selected among those either affiliated with the Swedish Animal Health Service (SvDHV) with a herd veterinarian working for SvDHV, or were herds with previous contact with researchers at the National Veterinary Institute.

Each herd was visited once to collect detailed information on the antimicrobial consumption over the past year expressed as volume or mass by product, strength of product, administration route and age category (sows, piglets, weaners and finishers).

Antimicrobial usage was quantified using the ABcheck.UGent™ online tool developed by the Unit for Veterinary Epidemiology of the Faculty of Veterinary Medicine, University of Ghent (http://www.abcheck.ugent.be/). The ABcheck converts recorded antimicrobial use to active substance expressed as mg and then to treatment incidence (TI) based on Defined Daily Doses Animal (DDDA). The TI is given as the number of DDDAs per 1000 pig-days at risk which is equivalent to how many pigs per 1000 pigs that receive a dose of antimicrobials each day (Timmerman et al., 2006) The TI was calculated for each herd and age group in accordance with Timmerman et al. (2006) as follows:

$$TI = \frac{\text{Total amount of antimicrobials administered (mg)}}{\text{DDDA (mg/kg) x number of days at risk x kg animal at risk}} \text{ X 1000 pigs at risk}$$

Previously established consensus DDDAs, as described by Postma and co-workers (2014), were used. Briefly, DDDAs were established by taking the mean of the recommended dose per kg for all products authorised for pigs with the same active substance and the same administration route.

Additionally, data was collected on the internal and external biosecurity, technical performances, health characteristics and vaccination practices. A causal path was designed to study associations between biosecurity status, antimicrobial usage, and production parameters.

All data collection was performed according to standardized methodologies allowing for comparison of results between herds and countries.

RESULTS AND DISCUSSION

Treatment incidences expressed as the number of treatments per 1000 pig-days at risk for growing pigs over a standardized life span of 200 days (TI_{200d}) varied considerably between countries as shown in Figure 1. The lowest average TI_{200d} was observed for the Swedish (SE) herds with a TI of 22.7 (range; 1.6 – 116.0) followed by the French (FR) herds with a TI of 108.8 (range; 0.0 – 539.0), the Belgian (BE) herds with a TI of 142.9 (range; 0.0 – 531.1) and lastly German (DE) herds with a TI of 242.8 (range; 3.8 – 673.9) (Table 1). The Belgian and French herds did not differ significantly from each other ($p < 0.1$) whereas significant differences were observed between the other countries. In all countries, considerable variations between herds were observed (Figure 1; Table 1). of 243 in Germany (42 for the sows), in Belgium 143 (16 for sows), in France 108 (22 for sows) and in Sweden 23 (11 for sows) (Figure 1).

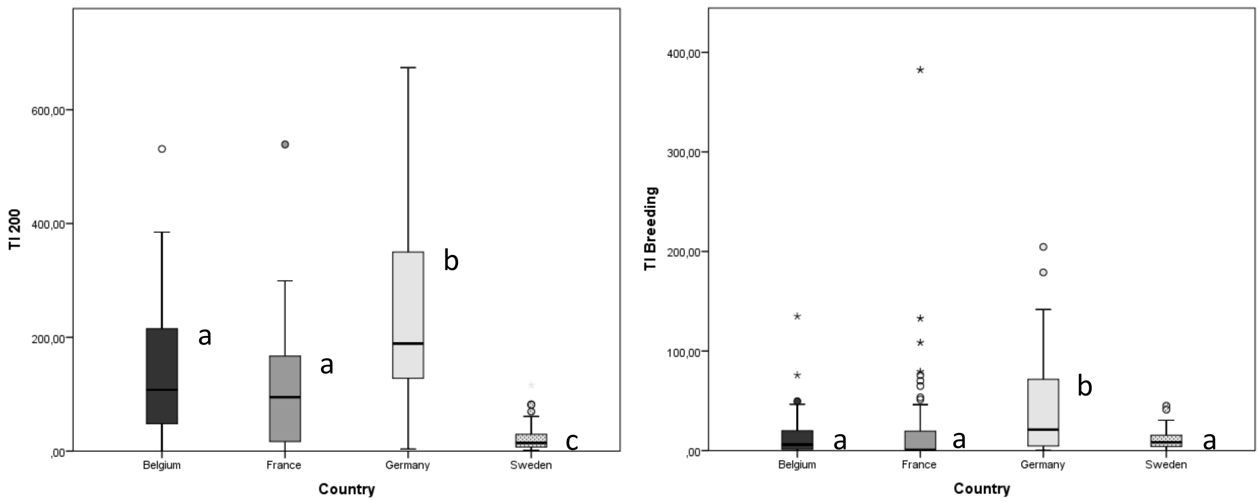

Figure 1. Antimicrobial treatment incidences (TI), expressed as treatment incidence per 1000 pig-days at risk, for pigs in farrow-to-finish herds in Belgium (n=47), France (n=60), Germany (n=60) and Sweden (n=60). TI200 denotes the overall TI for growing pigs with a standardised lifespan of 200 days. Different letters denote significant differences between countries within the respective age categories.

These results indicate that an average fattener pig was treated 10 times more with antimicrobials in Germany than in Sweden. Antimicrobials were most often applied through feed or water except in the Swedish herds where parenteral treatments were most frequent. Aminopenicillins was most commonly antimicrobial class used. On country level, overall use of third and fourth generation cephalosporins constituted 10.8% (BE), 1.2% (FR), 1.8% (DE) and 0.0% (SE) of total use. For fluoroquinolones the corresponding figures were 5.3% (BE), 0.4% (FR), 1.3% (DE) and 1.3% (SE).

When within herd TIs were investigated for the different age categories, a significant association ($p < 0.01$) was found between TIs for different age groups (Figure 2).

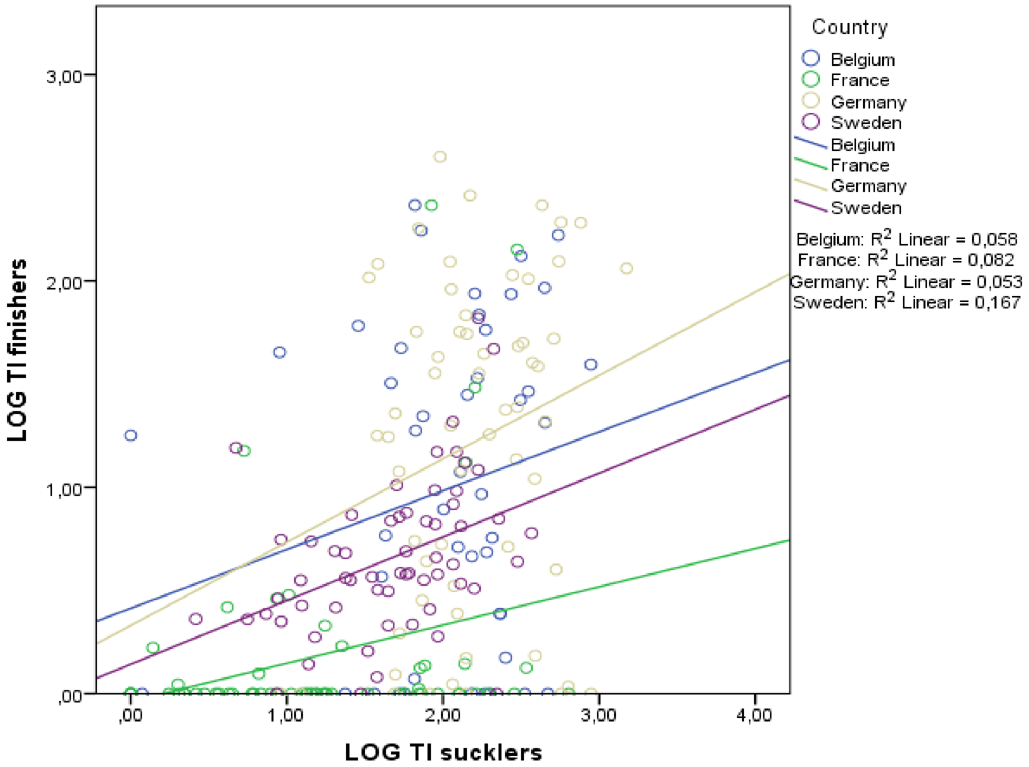

Figure 2. Within-herd associations of log-transformed treatment incidences (TI) per 1000 pig-days at risk for different age categories.

As the biosecurity is concerned, Sweden had on average the highest total biosecurity status (63.7), followed by Germany (63.0), France (58.6) and Belgium (57.8) In all countries external biosecurity (measures taken to prevent disease introduction) scored higher compared to internal biosecurity (measures taken to prevent within herd disease transmission) which has been observed in previous studies.

It was found that antimicrobial usage in sows was significantly associated with the antimicrobial usage from birth till slaughter in the growers, the use of anti-inflammatory products in weaners and the number of pathogens vaccinated against, suggesting an overall higher disease pressure. Higher antimicrobial usage from birth till slaughter was associated with a shorter farrowing rhythm and a younger weaning age, whereas a better external biosecurity was related with a lower antimicrobial usage. A higher external biosecurity was associated with more weaned piglets per sow per year. The negative association observed between the biosecurity level and the estimated frequency of treatment against certain clinical signs of disease, used as a proxy for disease incidence, is consistent with the hypothesis that a higher biosecurity level results in healthier animals (Figure 3).

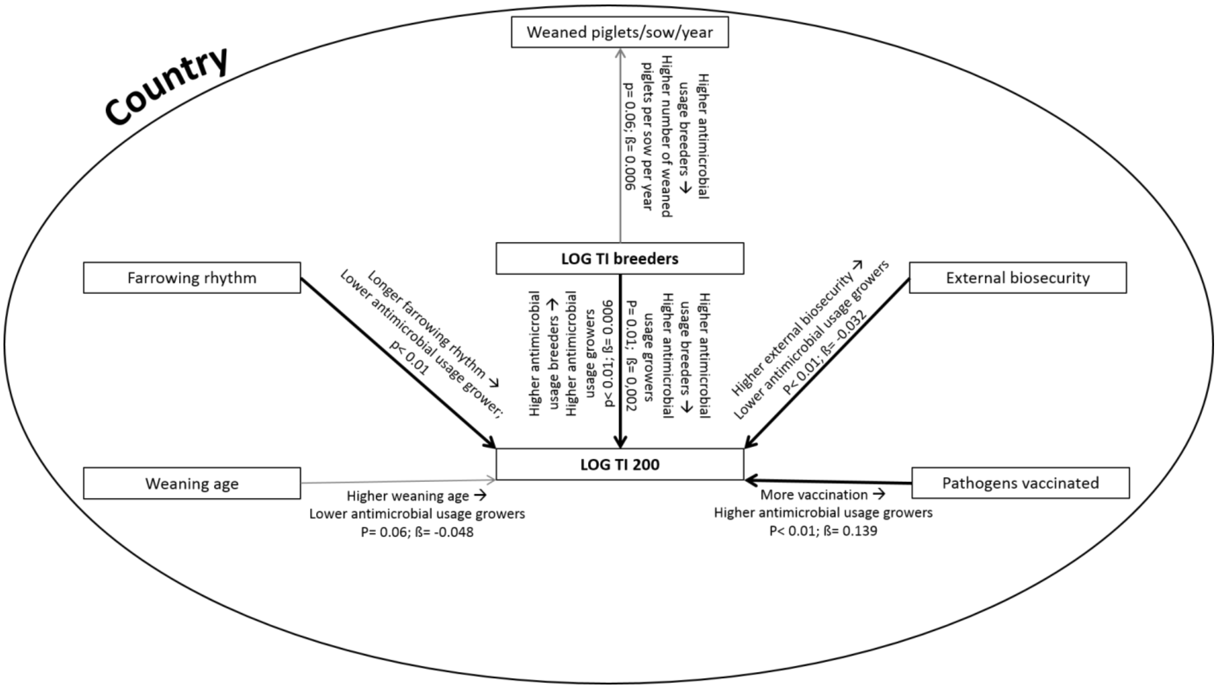

Figure 3: Causal pathway with statistical significant associations in the multivariable models for the TI 200 days and the TI Breeding associated with significant production, management or biosecurity variables. TI= treatment incidence (antimicrobial usage quantification), WSY= number of weaned piglets per sow per year. Black lines represent the result of a multivariable linear regression analysis based on data from 4 EU countries. The light gray line indicates $0.05<p<0.10$. The p-values and β-values correspond to the multivariable model. All models were corrected for the country effect by placing country as a fixed variable in the model, hence the circle around the figure.

Based upon the available data "44 top farmers" were identified that managed to combine both below national average usage of antimicrobials and above national average technical performances. These farmers were characterized by an on average higher internal biosecurity status and were generally located in a more favorable environment (lower pig density and limited contact with wildlife). They also treated less frequently against respiratory clinical symptoms in weaners and finishers.

CONCLUSION

Overall the study showed high variation both in antimicrobial usage, biosecurity and management practices indicating substantial room for improvement. Moreover some cross country associations were identified allowing for potential interventions such as using a longer farrowing rhythm, weaning of the piglets at an older age and improvement of the biosecurity status. At the same time, the improved biosecurity is expected to result in improve technical performances.

REFERENCES

Chantziaras, I., et al., Correlation between veterinary antimicrobial use and antimicrobial resistance in food-producing animals: a report on seven countries. J Antimicrob Chemother, 2014. 69(3): p. 827-34.

ESVAC, E., Sales of veterinary antimicrobial agents in 26 EU/EEA countries in 2012, in European Medicines Agency, European Surveillance of Veterinary Antimicrobial Consumption. 2014.

Grave, K., et al., Variations in the sales and sales patterns of veterinary antimicrobial agents in 25 European countries. J Antimicrob Chemother, 2014. 69(8): p. 2284-91.
Fillipitzi et al., Antimicrobial use in pigs, broilers and veal calves in Belgium. Vlaams Diergeneeskundig Tijdschrift, 2014, Vol 83 P: 215-224.
Timmerman, T., et al., Quantification and evaluation of antimicrobial drug use in group treatments for fattening pigs in Belgium. Prev Vet Med, 2006. 74(4): p. 251-63.

FARM-ECONOMIC ANALYSIS OF REDUCING ANTIMICROBIAL USE WHILST ADOPTING GOOD MANAGEMENT STRATEGIES ON FARROW-TO-FINISH PIG FARMS

Cristina Rojo-Gimeno[a,b§], Merel Postma[b§], Jeroen Dewulf[b], Henk Hogeveen[c], Ludwig Lauwers[a,d], Erwin Wauters[a,e]*

[a] *Social Sciences Unit, Institute for Agricultural and Fisheries Research. Burg. Van Gansberghelaan 115 box 2, 9820, Merelbeke, Belgium*

[b] *Department of Reproduction, Obstetrics and Herd Health, Veterinary Epidemiology Unit, Faculty of Veterinary Medicine, Ghent University, Salisburylaan 133, 9820 Merelbeke, Belgium*

[c] *Business Economics Group, Wageningen University, Hollandseweg 1, 6706 KN, Wageningen, The Netherlands*

[d] *Department of Agricultural Economics, Faculty of Bioscience Engineering, Ghent University, Coupure Links 653, 9000 Ghent, Belgium*

[e] *Department of Veterinary Sciences, University of Antwerp, Universiteitsplein 1, 2610 Wilrijk, Belgium*

[§] *shared first authorship * Corresponding author at: Institute for Agricultural and Fisheries Research, Social Sciences Unit, Burg. Van Gansberghelaan 115 box 2, 9820 Merelbeke, Belgium. Tel:+3292722384, Fax: +3292722341. E-mail address corresponding author: cristina.rojogimeno@ilvo.vlaanderen.be*

INTRODUCTION

Pig farming employs high amounts of antimicrobials (Dunlop et al., 1998; Callens et al., 2012; European Medicines Agency, 2013; MARAN, 2014; Rushton et al., 2014). A significant fraction of those are also administered in human medicine (Laxminarayan et al., 2013). Their extensive use in pig husbandry, as suggested by relevant studies, is linked to the selection and spread of resistant bacteria, which may be transferred interspecies through direct or indirect contact (Schwarz et al., 2001; Aarestrup, 2005; Chantziaras et al., 2014).
According to the most recent ESVAC report (European Medicines Agency, 2014), in 2012 Belgium was ranked 6th, out of 25 countries in the EU, in terms of the volume of sales of antimicrobials for food producing animals, the majority in pig production (Filippitzi et al., 2014). Unfortunately, more recent reports of antimicrobial surveillance in Belgium have shown that after a declining trend of the antimicrobial usage in food production animals, the consumption of such agents has increased by 1.3% in 2014 with respect to 2013 (BelVet-SAC, 2011, 2012, 2013, 2014). This is despite the efforts of the Center of Expertise on Antimicrobial Consumption and Resistance in Animals (AMCRA), whose guidelines are encouraged to be used by Belgian veterinarians to aid their judicious prescription of antimicrobial agents. These guidelines state, amongst others, that antibiotics cannot be used as substitutes for good hygiene, housing and appropriate feed. However, standard prophylactic antimicrobial treatments are often considered by farmers as an easier, cheaper and less labor-intensive way to prevent bad health conditions and to avoid repercussions on the productivity and, indirectly, on the farm-financial situation, compared to therapeutic treatments (Callens et al., 2012), or investments in infrastructure or disinfection on the farm (Filippitzi et al., 2014).

The relation between the use of antimicrobials and higher productivity is described in literature since the early 50's. However, it was already acknowledged that the farming conditions were inversely related to the productivity response to antimicrobials (Coates et al., 1951; Hill et al., 1953). Recent studies post 2000 demonstrate that the effect of antibiotics on productivity were lower than those from the early trials. Current production conditions in Europe, and most of the developed countries, have substantially improved in the last decades, consequently it is questionable whether the effect of antimicrobials on productivity will remain high (Rushton et al., 2015).

The adoption of general herd management strategies (e.g. biosecurity practices or specific vaccinations) can be noted as a more sustainable alternative to prophylactic antimicrobials (Postma et al., 2015). Moreover, higher levels of biosecurity are associated with improved average daily weight gain, feed conversion ratio and a decreased consumption of antibiotics (Laanen et al., 2013). As such, financial concerns seem to become a dominant factor for considering the adoption of biosecurity strategies (Visschers et al., 2015). On the one hand, veterinarians feel the need to give information about the economic impact of advised interventions (Gunn et al., 2008) while on the other hand, farmers have shown an inverse relationship between the willingness to adopt biosecurity practices and their estimated costs (Fraser et al., 2010). Farmers have shown interest in knowing the costs of biosecurity measures, as well as its benefits entailed (Laanen et al., 2014), but the lack of such insight still represents a limit, while such detailed information could foster awareness. To date, few studies have evaluated the economics of biosecurity compared to antibiotics. Two studies estimated the direct costs associated to the use of preventive strategies (Siekkinen et al., 2012; Miller and Dorn, 1990). Two cross-sectional studies, which also accounted for the indirect economic impact due to changes in technical parameters, found that farrow-to-finish pig farms who exhibited a higher biosecurity and health status were correlated with improved technical parameters and a higher economic margin (Corrégé et al., 2011; 2012) than the farms with lowest biosecurity status. The methodological weakness of these studies are the lack of a control group and their cross sectional nature, which may have caused an overestimation of the effect. This could be controlled with a longitudinal study.
This study aims to use a quasi-experimental longitudinal approach for assessing economic impacts of antimicrobial substitution for good management practices, in particular biosecurity strategies.

MATERIALS AND METHODS

The overall approach was a quasi-experimental design (Harris et al., 2006), in which treated farms were matched, using propensity scores (Dehejia and Wahba, 2002) with control farms. The latter were selected from the Flemish Farm Accountancy Data Network (FADN), an instrument for evaluating the income of agricultural holdings and the impacts of the Common Agricultural Policy. The treated farms received tailored advice regarding biosecurity, general management, vaccination and antimicrobial use. Technical parameters of pig production were recorded before and after the advice was supplied and implemented. To account for the technological progress of pig production and to reduce selection bias, propensity score matching (PSM) was used, which results in a difference in differences (DID), i.e. the treatment effect that is attributable to the improvement in biosecurity, general management practices, vaccination and the change in antimicrobials usage. This DID served as input data in a farm production-economic input-output model whereby differences in enterprise profit are calculated. Direct economic effects of improved biosecurity, increased vaccination and reduced antimicrobial use were determined using a cost accounting analysis based on interviews with farmers and various databases for prices and purchase costs, and also fed into the farm production-economic model. To account for the heterogeneity in the pig farming population, the economic input-output model was simulated for 11 virtual but representative farms, which were constructed out of the full FADN-sample of farrow-to-finish pig farms in Flanders for the years 2010, 2011 and 2012.

Treated farms' data collection

Out of 65 farms participating in the 'reduction of antimicrobials project', 50 were farrow-to-finish pig farms which were retained for the economic evaluation study. The treated farms were visited on 3 occasions between September 2010 and May 2014. On average 8 months elapsed between the 1st and 2nd visit and between the 2nd and 3rd visit. During the 1st visit, data on specific aspects of health management like the used vaccination scheme, characteristics of anthelmintic therapy, or performed diagnostic tests were collected. Furthermore, antimicrobial usage and biosecurity status were obtained. The biosecurity status of the farms was assessed using Biocheck.UGent. This is a risk-based weighted scoring system expressed from 0 to 100 for an objective evaluation of the biosecurity status of a pig herd, taking into account both internal and external biosecurity (Laanen et al., 2010, 2013). Data on the antimicrobial use was translated into a treatment incidence with the help of the ABcheck.Ugent calculation system (Timmerman et al., 2006; Postma et al., 2014). Data on technical performance was obtained through face-to-face surveys with the farmers, implying two technical parameters from the farrowing stage, litter size (LS) and farrowing index (FI) and two technical parameters from the finishing stage, average daily weight gain (ADWG) and mortality of the finishers (MF).

Based on the 1st visit information, a tailored advice plan was developed and disseminated to the farmers on the 2nd visit. This plan consisted of measures to improve internal and external biosecurity, general management, vaccination schemes and to reduce the use of antimicrobials. A follow-up of compliance to the given advice was conducted during 3rd visit. During this last visit, similar data as in the first visit were collected.

Propensity score matching of the control farms

Pig husbandry is a production system with rapid technological changes (Vrints and Deuninck, 2014) and therefore we cannot guarantee that the interventions implemented are the only reason behind the change in the technical parameters. More, our quasi-experimental approach may suffer from selection bias because treated farms were not randomly selected from the whole population of farrow-to-finish pig farms. To circumvent this problem, a methodology was introduced, PSM with DID estimation, which is, to the authors knowledge, novel in the field of animal health economics. Put simply, this technique searches for control farms in a database with an as equal as possible probability to be in the treatment group and matches each treated farm with such a control farm. The outcome of the PSM is the DID which accounts for the difference between the after-before difference in the treated group versus the control group.

Data on 117 farrow-to-finish pig farms were obtained from the Flemish FADN dataset for 2011 and 2012. Those served to extract a control group with similar baseline characteristics to the treated group after computing a propensity score, whereby the conditional probability of being treated conditional on observed baseline covariates was calculated (Rosenbaum and Rubin, 1983; Austin, 2011).

The analysis was conducted in the R (R development Core Team 2013) package matching (http://CRAN.R-project.org/package=Matching) in which a one-to-one nearest neighbor matching without replacing was used.

Direct net costs of the interventions

The direct net costs of the tailored advice were assessed using a cost accounting analysis. Prices on commodities (e.g. boots, gloves, disinfectant products, etc.) were gathered from an online web shop often used by Belgian farmers (http://www.agrologic.be). Veterinary costs, including the analysis of samples, were obtained from Animal Health Care Flanders. The time spent performing certain proposed intervention tasks (such as changing boots between departments) was gathered from previous literature, consultation with experts, assumptions and common sense. Some purchased commodities were durable inputs, this means they can be used over a period of years on the farm, and incurred fixed costs (e.g. boots, boards, brooms). Therefore, depreciation was accounted for with a straight line method (Rushton, 2009a).
Vaccination prices were obtained through a questionnaire sent to 2 veterinarians active in pig veterinary medicine.

Information on the antibiotic products used on the farms was obtained by asking the farmer for their prophylactic and curative treatments. Further, the invoices of the herd veterinarian, and/or the invoices from the feed mills on purchase of antibiotic products over the year preceding the visit was used. The prices (in €/g or €/ml) of the used antibiotic were multiplied by the amount of g or ml of antimicrobial used by the animals treated to calculate the costs of the antibiotics in the 1st and the 3rd visit.

Input-output production economic model

Besides the direct costs, the interventions may also have indirect economic consequences due to changes in technical performance. We accounted for these indirect effects with a production-economic input-output model operationalized in Excel (Van Meensel et al., 2010), of which gross margin is the main outcome. Gross margin is defined as the farm revenues from the output minus the variable costs attributable to it (Rushton, 2009b) and it is described in Eq. (1).

$$\text{Gross margin (GM)} = \text{Revenues} - \text{Variable costs} \qquad (1)$$

We needed to add several adaptations to this previously developed simulation model. First, since the adoption of some strategies incurred fixed costs due to the purchase of durable inputs which incurred depreciation and extra labor, as an opportunity costs, gross margin was an inadequate economic indicator for our goal. Therefore, the enterprise profit (Rushton, 2009b) which is defined as the gross margin minus the fixed costs, was a more suitable indicator (Eq. (2)).

$$\text{Enterprise profit} = \text{GM} - \text{Total Fixed Costs} \qquad (2)$$

Data on the total fixed costs incurred by the 11 representative farms was not available. However, it was assumed that the total fixed costs, excluding the fixed costs associated to the implemented interventions, were equal before and after the intervention which allowed us to estimate the difference in enterprise profit after versus before the interventions (Eq. (5)).

$$\Delta\text{Enterprise profit}_{\text{after}-\text{before}} = \text{GM}_{\text{after}} - \text{Fixed Costs Intervention} - \text{GM}_{\text{before}} \qquad (3)$$

In addition, the initial deterministic simulation model was also customized into a Monte-Carlo-based stochastic model with @Risk 6.0 (Palisade Corporation, California) which allowed to insert two types of stochasticity. The first type reflects price volatility of the input and output prices: feed for sows (€/kg), feed for piglet (€/kg), and finishers (€/kg), finishing pigs (€/kg) and sold piglets (€/piglet). Data on the volatility of the feed prices was extracted from the Belgian national statistics (statistics Belgium) likewise historical prices of finishing pigs and piglets were obtained from a Belgian feed company for the years 2010, 2011, and 2012.

The second type of stochasticity accounted for was uncertainty regarding the treatment effect on the technical parameters and regarding the direct net costs of the treatment.
Simulations were used to estimate the effect on the enterprise profit in 11 representative Flemish farrow-to-finish pig farms due to the change on the technical parameters and on the direct costs. The simulation started from the situation of the farm before the intervention and compared it to the simulated situation after the intervention was implemented. The final model was run with 1,000 iterations for each of the 11 representative Flemish farrow-to-finish pig farms. The mean, standard deviation and 95% confidence interval of the $\Delta \text{Enterprise profit}_{\text{after}-\text{before}}$ were estimated in €/average present finisher pig/year, €/finisher pig/year and €/sow/year.

RESULTS

Descriptive statistics

A total of 48 of the 50 treated farms remained during the whole study period. Treated farms had on average more sows (301) than control farms (175).

Technical parameters

At baseline level, treated farms showed a slightly higher FI, LS and MF than control farms. After the second visit treated farms showed an improved LS, ADWG and MF.

Propensity score analysis

The MF was significantly lower on treated farms than on control farms (mean -1.13%, SE: 0.02).

Direct net costs of the interventions

The median of the total direct net costs on the treated farms was reduced by -€2.68 /sow/year between visits 2 and 3. This was mainly caused by a reduction in antimicrobial usage, especially on the prophylactic treatments administered to the piglets, leading to a reduction in costs, median -€7.68/sow/year, which showed a large variation between farms. Increased biosecurity and more vaccinations resulted in respectively €4.76/sow/year (median €3.96/sow/year) and €5.94/sow/year (median €0.00/sow/year) higher costs which had a smaller variation compared to the reduced costs on antimicrobials.

Enterprise profit

Without taking volatility of prices into account, farms presented on average +€107.47/sow/year higher difference of enterprise profit after the antimicrobial use was reduced than before. On the other hand, when the price volatility was accounted for, the difference of the enterprise profit after versus before the antimicrobial use lower than when volatility was not modelled, but it was still positive with +€2.45/finisher pig/year or +€39.21/sow/year.

DISCUSSION

In this study the reduction of antimicrobial use, accompanied by improved biosecurity, optimized vaccination and general husbandry practices yielded a reduction in net direct costs between the 3rd and the 1st visit, which was mostly due to a reduction on the usage of prophylactic treatment for the piglets (Postma and Dewulf, 2013). This implies that prophylactic treatments entail high costs. In our study, the use of antimicrobials was replaced by the implementation of management strategies, namely biosecurity and new vaccinations. Their additional costs were lower than the eliminated costs associated with a reduction of antimicrobial use. Similar results were found by a recent randomized clinical trial which demonstrated that the efficacy of administering antimicrobial metaphylaxis in finishing pigs was limited to those with lowest starting weight, and even then the costs of the antimicrobials will surpass the benefits entailed due to improved productivity levels (Ramirez et al., 2015). Our results suggest that, in spite of the farmers' general perception (Callens et al., 2012), antimicrobials are not necessarily cheaper than investing in adjusting the management strategies of the farm. The results of this paper can be used by veterinarians to motivate pig farmers to reduce their current use of antimicrobial treatments and to shift to use more sustainable practices like biosecurity strategies or vaccinations.

The average Flemish farrow-to-finish pig farm exhibited better parameters in 2011 (ADWG=659.90 g/day, MF=3.30%, FI=2.20 farrowing/sow/year, LS=12.20 living piglets/sow/year) and 2012 (ADGW=652.80 g/day, MF=2.90%, FI= 2.30 farrowing/sow/year, LS=12.40 living piglets/sow/year) (Vrints and Deuninck, 2014) than our control farms, but worse than the treated farms. This may have been caused by selection bias, in which participants, who are the forerunners in the reduction of antimicrobial usage, may have had higher production technical parameters and may have been more prone to participate in such a project. We accounted for it by computing a propensity score and the DID, which is intended to eliminate some of the selection bias, to estimate the attributable effect of the implemented interventions on the technical parameters. The results are in line with results of previous studies in which pig farms with higher biosecurity status were associated with better technical parameters (Corrégé et al., 2011; Laanen et al., 2013). To the authors' knowledge, the present study is one of the few in the field of animal health economics that conducted propensity score analysis. Whereas this statistical technique is extensively used in agricultural economics (e.g., Mendola, 2007), and is described for the use in veterinary epidemiology by Dohoo et al., (2009), we could only find one article concerned with economics of animal health in which this methodology is performed to match a control group to a treated group (Key and Mcbride, 2014). In observational studies such as the present study, in which to conduct an experiment with random allocation of treatment is cumbersome, propensity score analysis demonstrated to be especially advantageous (LaLonde, 1986; Mendola et al., 2007).
With respect to the net income of pig farms, at the time of the preparation of this manuscript, price evolutions were, particularly adverse with high prices for the feed and low prices for the finishers. The situation has been more or less like this from 2007 till now (Anonymous, 2015). our results showed that enterprise profit was positive for both the model which accounted for volatility, which is more realistic, and for the model which did not account for volatility, which suggests that results are robust: even with volatile prices, on average for the 11 representative farms, the enterprise profit was +€2.45/finisher pig/year. Two cross-sectional studies in farrow-to-finish pig farms conducted in France found that farms which had the highest biosecurity status compared with those with the lowest were associated with an economic margin of

€180/sow/year (Corrégé et al., 2011) and €200/sow/year (Corrégé et al., 2012). If our results are translated into the same units there was a difference of enterprise profit between the treated and control farms of €39.21/sow/year which is smaller than the effect observed by their studies. This may respond to the cross-sectional design of the studies and the lack of control farms, which may have led to an overestimation of the economic margin. Moreover, volatility of the inputs and output prices was not accounted for in their study which may explain why the net benefit is higher than the resulted from our model with price volatility (€39.21/sow/year) and more similar to the results from our model without volatility (€107.47/sow/year).

In our study, we demonstrated that reduced antimicrobial use is possible without hampering the enterprise profit, more, high probability exists that, depending on the prices of feed and meat, the net profit is higher for farms which reduced antimicrobial use. Because positive profitability impacts of management changes in an adverse market environment is even more important, the results of this study can be crucial to aid veterinarians and other stakeholders to incentive pig farmers to reduce their current use of antimicrobials.

REFERENCES

Aarestrup, F.M., 2005. Veterinary drug usage and antimicrobial resistance in bacteria of animal origin. Basic Clin. Pharmacol. Toxicol. 96, 271–281. doi:10.1111/j.1742-7843.2005.pto960401.x

Anonymous, 2015. Actualisatie van de studie over de varkenskolom. Available at: http://economie.fgov.be/nl/binaries/Actualisatie_studie_varkenskolom_mei2015_tcm325-267698.pdf

Austin, P.C., 2011. An Introduction to Propensity Score Methods for Reducing the Effects of Confounding in Observational Studies. Multivar. Behav. Res. 46, 399–424. doi:10.1080/00273171.2011.568786

Statistics Belgium [WWW Document]. URL http://statbel.fgov.be/nl/statistieken/cijfers/ (accessed 1.7.2015).

BelVet-SAC, 2011. Belgian Veterinary Surveillance of Antimicrobial Consumption National consumption report 1–39. Available at: http://www.belvetsac.ugent.be/pages/home/BelvetSAC_report_2011%20finaal.pdf

BelVet-SAC, 2012. Belgian Veterinary Surveillance of Antimicrobial Consumption National consumption report 1–39. Available at: http://www.belvetsac.ugent.be/pages/home/BelvetSAC_report_2012%20finaal.pdf

BelVet-SAC, 2013. Belgian Veterinary Surveillance of Antimicrobial Consumption National consumption report 1–39. Available at: http://www.belvetsac.ugent.be/pages/home/BelvetSAC_report_2013%20finaal.pdf

BelVet-SAC, 2014. Belgian Veterinary Surveillance of Antimicrobial Consumption National consumption report 1–39. Available at: http://www.belvetsac.ugent.be/pages/home/BelvetSAC_report_2014%20finaal.pdf

Callens, B., Persoons, D., Maes, D., Laanen, M., Postma, M., Boyen, F., Haesebrouck, F., Butaye, P., Catry, B., Dewulf, J., 2012. Prophylactic and metaphylactic antimicrobial use in Belgian fattening pig herds. Prev. Vet. Med. 106, 53–62. doi:10.1016/j.prevetmed.2012.03.001

Chantziaras, I., Boyen, F., Callens, B., Dewulf, J., 2014. Correlation between veterinary antimicrobial use and antimicrobial resistance in food-producing animals: A report on seven countries. J. Antimicrob. Chemother. 69, 827–834. doi:10.1093/jac/dkt443

Coates, M.E., Dickinson, C.D., Harrison, G.F., Kon, S.K., Cummins, S.H. and Cuthbertson, W.F.J., 1951. Mode of action of antibiotics in stimulating growth pf chicks. Nature 168 (4269) 332-332. DOI 10.1038/168332a0.

Corrégé, I., Berthelot, N., Badouard, B., Aubry, A., Hemonic, A., 2011. Biosecurity, Health Control, Farming Conception and Management Factors : Impact on Technical and Economic Performances, in: Proceedings of the 15th International Congress of the International Society for Animal Hygiene Vienna, Austria, 3-7 July 2011, Volume 2, Vienna, Austria, pp. 689–691.

Corrégé, I., Fourchon, P., Le Brun, T., Berthelot, N., 2012. Biosécurité et hygiène en élevage de porcs: état des lieux et impact sur les performances technico-économiques. Journées Recherche Porcine 44, 101–102.

Dehejia, R.H., Wahba, S., 2002. Propensity Score-Matching Methods for Nonexperimental Causal Studies. Rev. Econ. Stat. 84, 151–161. doi:10.1162/003465302317331982

Dohoo, I. Martin, W., Stryhn, H., 2009. Confounding: Detection and control, in: Veterinary Epidemiologic Research. Ver Inc, Charlottetown, Canada, pp. 271–323.

European Medicines Agency, 2013. Sales of veterinary antimicrobial agents in 25 EU / EEA countries in 2011. Third ESVAC report. Eur. Med. Agency 57. doi:EMA/236501/2013. Available at: http://www.ema.europa.eu/docs/en_GB/document_library/Report/2013/10/WC500152311.pdf

European Medicines Agency, 2014. Sales of veterinary antimicrobial agents in 26 EU/EEA countries in 2012. Fourth ESVAC report. Eur. Med. Agency 58. Available at: http://www.ema.europa.eu/docs/en_GB/document_library/Report/2014/10/WC500175671.pdf

Filippitzi, M.E., Callens, B., Pardon, B., Persoons, D., Dewulf, J., 2014. Antimicrobial use in pigs, broilers and veal calves in Belgium. Vlaams Diergeneeskd. Tijdschr. 83(5) 215-224.

Fraser, R.W., Williams, N.T., Powell, L.F., Cook, A. J.C., 2010. Reducing Campylobacter and Salmonella infection: Two studies of the economic cost and attitude to adoption of on-farm biosecurity measures. Zoonoses Public Hlth. 57, 109–115. doi:10.1111/j.1863-2378.2009.01295.x

Gunn, G.J., Heffernan, C., Hall, M., McLeod, A., Hovi, M., 2008. Measuring and comparing constraints to improved biosecurity amongst GB farmers, veterinarians and the auxiliary industries. Prev. Vet. Med. 84, 310–323. doi:10.1016/j.prevetmed.2007.12.003

Harris, A., McGregor, J., Perencevich, E., Furuno, J., Zhu, J., Peterson, D., Finkelstein, J., 2006. The Use and interpreatation of Quasi-Experimental Studies in Medical Informatics. J Am Med Inf. Assoc. 13, 16–23. doi:10.1197/jamia.M1749.Background

Hill, D.C., Branion H.D., Slinger, S.J., Anderson, G.W., 1953. Influence of environment on the growth response of chicks to penicillin. Poultry science 32 (3), 462-66 doi:10.3382/ps0320462

Key, N., Mcbride, W.D., 2014. Sub-therapeutic antibiotics and the efficiency of U.S. hog farms. Am. J. Agric. Econ. 96, 831–850. doi:10.1093/ajae/aat091

Laanen, M., Beek, J., Ribbens, S., Vangroenweghe, F., Maes, D., Dewulf, J., 2010. Bioveiligheid op Varkensbedrijven: Ontwikkeling van een Online Scoresysteem en de Resultaten van de Eerste 99 Deelnemende Bedrijven. Vlaams Diergeneeskd. Tijdschr. 79, 302–306.

Laanen, M., Persoons, D., Ribbens, S., de Jong, E., Callens, B., Strubbe, M., Maes, D., Dewulf, J., 2013. Relationship between biosecurity and production/antimicrobial treatment characteristics in pig herds. Vet. J. 198, 508–512. doi:10.1016/j.tvjl.2013.08.029

Laanen, M., Maes, D., Hendriksen, C., Gelaude, P., De Vliegher, S., Rosseel, Y., Dewulf, J., 2014. Pig, cattle and poultry farmers with a known interest in research have comparable perspectives on disease prevention and on-farm biosecurity. Prev. Vet. Med. 115, 1–9. doi:10.1016/j.prevetmed.2014.03.015

LaLonde, R., 1986. Evaluating the econometric evaluations of training programs with experimental data. American Economic Review 76 (September), 604-620.

Laxminarayan, R., Duse, A., Wattal, C., Zaidi, A.K.M., Wertheim, H.F.L., Sumpradit, N., Vlieghe, E., Hara, G.L., Gould, I.M., Goossens, H., Greko, C., So, A.D., Bigdeli, M., Tomson, G., Woodhouse, W., Ombaka, E., Peralta, A.Q., Qamar, F.N., Mir, F., Kariuki, S., Bhutta, Z.A., Coates, A., Bergstrom, R., Wright, G.D., Brown, E.D., Cars, O., 2013. Antibiotic resistance-the need for global solutions. Lancet Infect. Dis. 13, 1057–1098. doi:10.1016/S1473-3099(13)70318-9

MARAN, 2014. Consumption of antimicrobial agents and antimicrobial resistance among medically important bacteria in The Netherlands in 2013 1–165. Available at https://www.wageningenur.nl/upload_mm/7/8/9/52388c6c-858c-483c-b57d-227029fe778a_005738_Nethmap_2013%20def_web.pdf

Mendola, M., 2007. Agricultural technology adoption and poverty reduction: A propensity-score matching analysis for rural Bangladesh. Food Policy 32, 372–393. doi:10.1016/j.foodpol.2006.07.003

Miller, G.Y., Dorn, C.R., 1990. Costs of swine diseases to producers in Ohio. Prev. Vet. Med. 8, 183–190. doi:10.1016/0167-5877(90)90010-F

Postma, M., Dewulf, J. 2013. International awareness demanded. Fleischwirtschaft international: Journal for meat production and meat processing 2, 104-107. Available at: http://www.abcheck.ugent.be/v2/download/FLWI_02_2013_Seite_104-106.pdf

Postma, M., Sjolund, M., Collineau, L., Losken, S., Stark, K.D.C., Dewulf, J., 2014. Assigning defined daily doses animal: a European multi-country experience for antimicrobial products authorized for usage in pigs. J. Antimicrob. Chemother. 70, 294–302. doi:10.1093/jac/dku347

Postma, M., Stärk, K.D.C., Sjölund, M., Backhans, A., Beilage, E.G., Lösken, S., Belloc, C., Collineau, L., Iten, D., Visschers, V., Nielsen, E.O., Dewulf, J., 2015. Alternatives to the use of antimicrobial agents in pig production: A multi-country expert-ranking of perceived effectiveness, feasibility and return on investment. Prev. Vet. Med. 118, 457–466. doi:10.1016/j.prevetmed.2015.01.010

Ramirez, C.R., Harding, A.L. Forteguerri, E.B.R., Aldrige, B.M., Lowe, J.F., 2015. Limited efficacy of antimicrobial metaphylaxis in finishing pigs: A randomized clinical trial. Prev Vet Med 121 176-178.

Rosenbaum, P.R., Rubin, D.B., 1983. "The Central Role of the Propensity Score in Observational Studies for Causal Effects" Biometrika. 70 SRC, 41–55.

Rushton, J., 2009a. Livestock production economics, in: The Economics of Animal Health and Production. CAB International, Wallingford, UK, pp. 16–46.

Rushton, J., 2009b. Economic Analysis tools, in: The Economics of Animal Health and Production. CAB International, Wallingford, UK, pp. 65–107.

Rushton, J., Pinto Ferreira, J., Stärk, K.D.C., 2014. Antimicrobial resistance: the use of antimicrobials in the livestock sector, OECD PUblishing. Available at: http://www.oecd-ilibrary.org/docserver/download/5jxvl3dwk3f0.pdf?expires=1438346624&id=id&accname=guest&checksum=BD5665910EA37A2D4F33410E78B9CC0D

Rushton, J., 2015. Anti-microbial use in animals: how to assess the trade-offs. Zoonoses and Public Health 62 (suppl.1) 10-21. doi: 10.1111/zph.12193

Schwarz, S., Kehrenberg, C., Walsh, T.R., 2001. Use of antimicrobial agents in veterinary medicine and food animal production. Int. J. Antimicrob. Agents 17, 431–437. doi:10.1016/S0924-8579(01)00297-7

Siekkinen, K.M., Heikkilä, J., Tammiranta, N., Rosengren, H., 2012. Measuring the costs of biosecurity on poultry farms: a case study in broiler production in Finland. Acta Vet. Scand. 54, 12. doi:10.1186/1751-0147-54-12

Timmerman, T., Dewulf, J., Catry, B., Feyen, B., Opsomer, G., Kruif, A. De, Maes, D., 2006. Quantification and evaluation of antimicrobial drug use in group treatments for fattening pigs in Belgium. Prev. Vet. Med. 74, 251–263. doi:10.1016/j.prevetmed.2005.10.003

Van Meensel, J., Kanora, A., Lauwers, L., Jourquin, J., Goossens, L., Van Huylenbroeck, G., 2010. From research to farm: Ex ante evaluation of strategic deworming in pig fnishing. Vet. Med. (Praha). 55, 483–493.

Visschers, V.H.M., Backhans, A., Collineau, L., Iten, D., Loesken, S., Postma, M., Belloc, C., Dewulf, J., Emanuelson, U., Beilage, E.G., Siegrist, M., Sjölund, M., Stärk, K.D.C., 2015. Perceptions of antimicrobial usage, antimicrobial resistance and policy measures to reduce antimicrobial usage in convenient samples of Belgian, French, German, Swedish and Swiss pig farmers. Prev. Vet. Med. 119, 10–20. doi:10.1016/j.prevetmed.2015.01.018

Vrints, G., Deuninck, J., 2014. Technische en economische resultaten van de varkenshouderij op basis van het Landbouwmonitoringsnetwerk. Boekjaren 2011-2013. Brussel. Available at: https://www.vlaanderen.be/nl/publicaties/detail/technische-en-economische-resultaten-van-de-varkenshouderij-op-basis-van-het-landbouwmonitoringsnetwerk-boekjaren-2011-2013

WHO, 2000. Global Principles for the containment of antimicrobial resistance in animals intended for food, World Health Organisation. Geneva, Switzerland. Available at: http://whqlibdoc.who.int/hq/2000/who_cds_csr_aph_2000.4.pdf

SEASONAL VARIATION IN PREVALENCE OF DIFFERENT RESPIRATORY PATHOGENS DURING POST-WEANING AND FATTENING PERIOD IN BELGIAN AND DUTCH PIG HERDS USING A TRACHEA-BRONCHIAL SWAB TECHNIQUE

Vangroenweghe Frédéric
Elanco Animal Health, BU Swine & Poultry, Plantijn en Moretuslei 1 – 3de verdiep, 2018 ANTWERPEN, Belgie.
vangroenweghefr@elanco.com

INTRODUCTION

Besides *Mycoplasma hyopneumoniae (M.hyo)*, many other viruses and bacteria can be concurrently present in pigs with respiratory problems, provoking the disease complex known as Porcine Respiratory Disease Complex (PRDC). This complex is of major economic importance due to decreased growth, increased feed conversion, increased weight variation, mortality, increased numbers of runt pigs and an important consumption of antibiotics. Therefore, a thorough diagnostic approach is necessary in order to identify the etiologic agents involved in the PRDC problem in each individual farm. Diagnosis of infections with these pathogens can be performed using different approaches (Sibila et al., 2009), such as clinical examination, necropsy with additional analysis (bacteriology, histology, Polymerase Chain Reaction (PCR)), slaughterhouse checks of affected lungs (Fraile et al., 2010; Meyns et al., 2011), serological examination of relevant animal groups (Fraile et al., 2010; Meyns et al., 2011) and the direct identification of the pathogens through PCR techniques (Calsamiglia et al., 1999; Marois et al., 2010; Fablet et al., 2012). A few years ago, a new sampling technique (Fablet et al., 2010) was developed and validated for the detection of *M.hyo* in pigs using PCR, namely the tracheo-bronchial swab (TBS) technique. With a further extension of this technique, different PRDC pathogens present at the level of the trachea-bronchial junction of pigs suffering clinical symptoms of respiratory distress can be recovered and analyzed through PCR-analysis.

The aim of the present study was to obtain data on the variation in distribution of different pathogens involved in PRDC in closed pig herds in Belgium and The Netherlands using the TBS technique during the different seasons of the year.

MATERIALS AND METHODS

Herd inclusion criteria and animal selection

Six hundred and twenty-four pig farms distributed throughout Belgium and The Netherlands were sampled using the TBS technique from 1st January 2012 till 30th September 2015. Inclusion criteria for the herds were the presence of respiratory distress in one or several age categories of piglets or pigs, including sneezing, nasal discharge and coughing. In every herd, at least 20 coughing piglets or pigs were sampled in at least two age groups (3-5, 6-11 and 12-20 weeks of age). In order to sample the relevant piglets or pigs, affected animals were marked by the farmer or the swine veterinarian from two days before the sampling event.

Tracheo-bronchial swabs sampling

TBS samples were obtained following restraint of the piglets with a nose snare, and subsequent use of a mouth opener. The aspiration tube used (CH12 × 50 cm, Medinorm) was inserted through the mouth and glottis down to the tracheobronchial bifurcation where mucus was collected through gentle swab movement. The tip of the swab was collected in a sterile 10 mL polystyrene tube (MLS), mixed with 1 mL sterile saline and kept at 3–5 °C until analysis within 48 h of sampling.

Tracheo-bronchial swab sample analysis

The material collected by TBS was analyzed using mPCR and/or dPCR (IVD GmbH, Hannover, Germany). Briefly, nucleic acid was extracted from TBS using an RNA/DNA isolation kit (MagMAX Pathogen RNA/DNA Kit, Life Technologies) and an automated nucleic acid isolation processor (MagMAX Express 96 processor, Life Technologies) based on magnetic bead technology. One microlitre of TBS was centrifuged for 5 min at 16,000 *g*, the pellet suspended in 400 μL lysis buffer, and 400 μL of the suspension was used as the sample. If no pellet was observable, 300 μL of the TBS was used as the sample. Bead mix and lysis/binding solution were added and the mix transferred onto a 96-well plate in the processor. Nucleic acid isolation was performed according to the manufacturer's instructions. A multiplex [porcine reproductive and respiratory syndrome virus (PRRSV), *Mycoplasma hyopneumoniae* (*M.hyo*), swine influenza virus (SIV) and porcine circovirus 2 (PCV-2)] PCR assay were used to detect the different pathogens in the TBS. PCR results were reported as negative or positive for the presence of SIV, PCV-2 and *M.hyo*. For PRRSV, strain type EU/US or both was also reported.

Data categorization for seasonality

In order to assess associations between climatic parameters and PRDC infection, herds were categorized into four groups based on the sampling season. Sampling was undertaken at the following rates in each season: S1 (winter), 174 herds, 3810 pigs; S2 (spring), 177 herds, 4329 pigs; S3 (summer), 156 herds, 4185 pigs; and S4 (autumn), 237 herds, 5622 pigs.

RESULTS

The results obtained for *M.hyo*, SIV, PCV-2 and PRRSV (EU, NA and EU/NA) for each age category (3-5, 6-11 and 12-25 weeks of age) are shown in Figure 1-3.

In all age group, a different prevalence is obtained depending on the season. In piglets of 3-5 weeks of age, SIV has the highest prevalence during autumn (S4, 32.5%), followed by spring (S2, 32.3%). PRRSV-EU (12.5%) and *M.hyo* (10.4%) were also highest during spring (S2). The 2nd highest prevalence for both pathogens (PRRSV-EU and *M.hyo*) was during winter (S1). During the summer months, overall prevalence of all examined PRDC pathogens were at their lowest level.

In the second stage of the nursery period (piglets of 6-11 weeks of age), the highest prevalences were observed during winter (S1) with PRRSV-EU at 37.4%, SIV at 23.9%, and *M.hyo* at 16.6%. In this age category, PCV-2 also started to play a role in PRDC pathology with prevalence of > 8.0% in all seasons.

In fattening pigs, prevalences for *M.hyo* (46-59%), PRRSV-EU (25-34%), PCV-2 (22-32%) and SIV (9-15%) did not differ a lot among seasons.

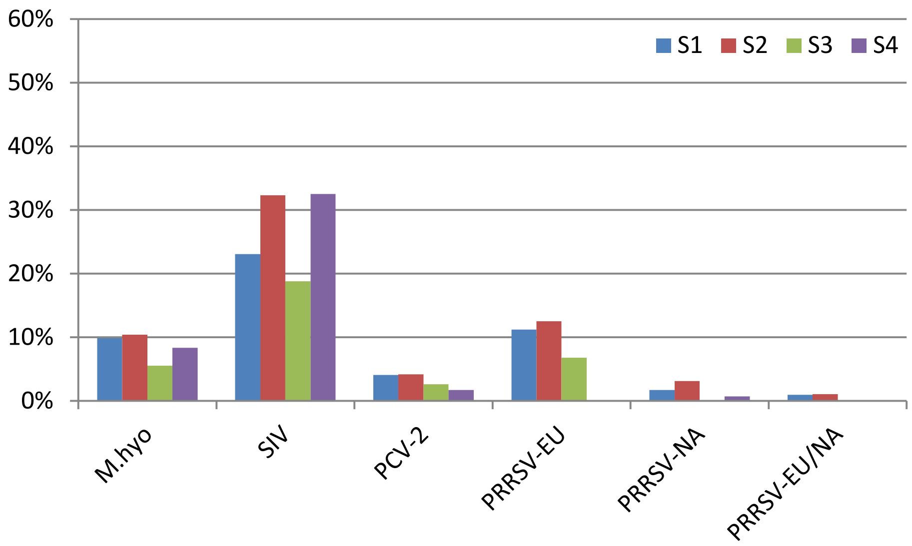

Figure 1. Prevalence (in %) of different porcine respiratory disease pathogens (*M.hyo*, *Mycoplasma hyopneumoniae*; SIV, Swine Influenza Virus; PCV-2, Porcine Circo Virus 2; PRRSV, Porcine Reproductive and Respiratory Syndrome Virus; EU, European strain; NA, North-American strain; EU/NA, European and North-American strain) during subsequent seasons (S1, winter; S2, spring; S3, summer; S4, autumn) using trachea-bronchial swab sampling in peri-weaned piglets of 3-5 weeks of age with symptoms of respiratory distress (coughing, sneezing).

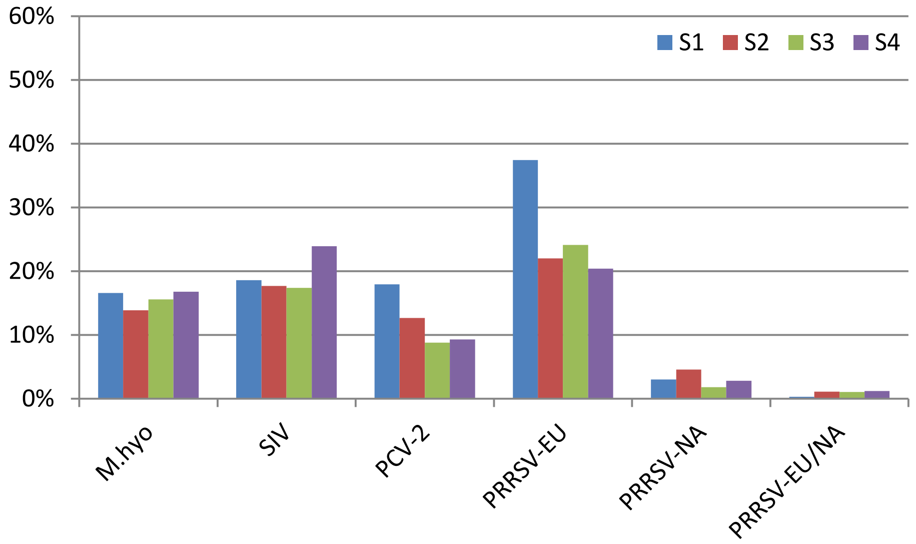

Figure 2. Prevalence (in %) of different porcine respiratory disease pathogens (*M.hyo*, *Mycoplasma hyopneumoniae*; SIV, Swine Influenza Virus; PCV-2, Porcine Circo Virus 2; PRRSV, Porcine Reproductive and Respiratory Syndrome Virus; EU, European strain; NA, North-American strain; EU/NA, European and North-American strain) during subsequent seasons (S1, winter; S2, spring; S3, summer; S4, autumn) using trachea-bronchial swab sampling in post-weaned piglets of 6-11 weeks of age in the second stage of nursery periode with symptoms of respiratory distress (coughing, sneezing).

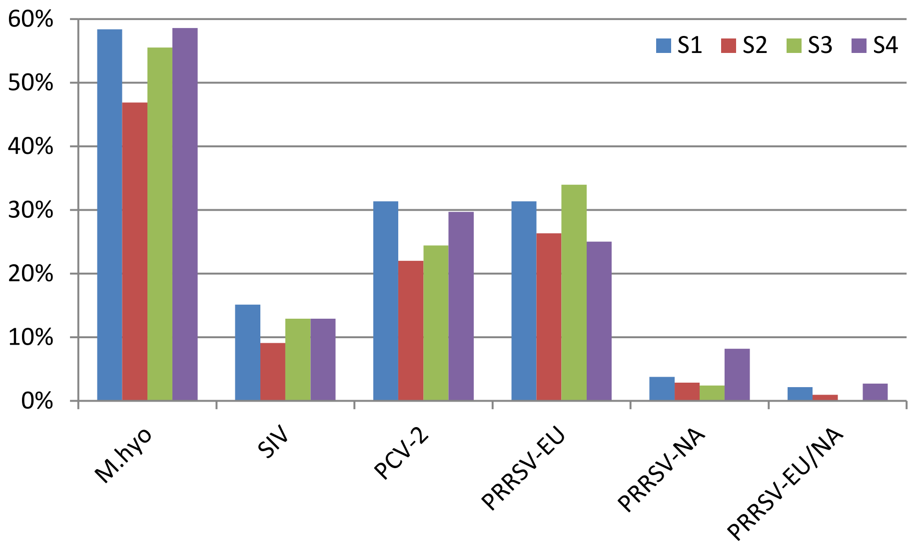

Figure 3. Prevalence (in %) of different porcine respiratory disease pathogens (*M.hyo*, *Mycoplasma hyopneumoniae*; SIV, Swine Influenza Virus; PCV-2, Porcine Circo Virus 2; PRRSV, Porcine Reproductive and Respiratory Syndrome Virus; EU, European strain; NA, North-American strain; EU/NA, European and North-American strain) during subsequent seasons (S1, winter; S2, spring; S3, summer; S4, autumn) using trachea-bronchial swab sampling in fattening pigs of 12-25 weeks of age with symptoms of respiratory distress (coughing, sneezing).

DISCUSSION

The present study clearly shows that different viral and bacterial pathogens responsible for PRDC may be present during the post-weaning and fattening period. Following analysis of seasonal variation, it can be concluded that depending on the pathogen, a clear variation in seasonal impact in the PRDC is present. This is in accordance with the observations by Segalès et al. (2011) for *M.hyo* in Spain. Concerning PRRSV, the most prevalent type was PRRSV-EU, whereas PRRSV-NA was far less frequent.

It is clear that in several herds, *M.hyo* is already present in piglets at weaning, further increasing in the second part of the nursery period. These observations are in accordance with other studies (Meyns et al., 2004; Meyns et al., 2006; Villarreal et al., 2010; Vangroenweghe et al., 2015). The prevalence of co-infection and triple infections of PRRSV with SIV, *M.hyo* or PCV-2 also may occur, but their prevalence is rather low as compared to double infections (results not shown).

Future research should be performed towards the effect of climatic data in relation to sampling date and other relevant risk factors in order to better understand the dynamics of the pathogens involved in PRDC in pigs.

CONCLUSIONS

In conclusion, the present study showed that many other respiratory pathogens are present during the post-weaning and fattening period, which may complicate the clinical picture of respiratory disease. Depending on the season of disease occurrence and subsequent sampling, different pathogens seem to be playing a role in the PRDC.

REFERENCES

Calsamiglia, M., Pijoan, C., Trigo, A., 1999. Application of a nested polymerase chain reaction assay to detect *Mycoplasma hyopneumoniae* from nasal swabs. Journal of Veterinary Diagnostic Investigation 11, 246–251.

Fablet, C., Marois, C., Kobisch, M., Madec, F., Rose, N., 2010. Estimation of the sensitivity of four sampling methods for *Mycoplasma hyopneumoniae* detection in live pigs using a Bayesian approach. Veterinary Microbiology 143, 238–245.

Fablet, C., Marois-Crehan, C., Simon, G., Grasland, B., Jestin, A., Kobisch, M., Madec, F., Rose, N., 2012. Infectious agents associated with respiratory diseases in 125 farrow-to-finish pig herds: A cross-sectional study. Veterinary Microbiology 157, 152–163.

Fraile, L., Alegre, A., Lopez-Jimenez, R., Nofrarias, M., Segales, J., 2010. Risk factors associated with pleuritis and cranio-ventral pulmonary consolidation in slaughter-aged pigs. The Veterinary Journal 184, 326–333.

Marois, C., Dory, D., Fablet, C., Madec, F., Kobisch, M., 2010. Development of a quantitative Real-Time TaqMan PCR assay for determination of the minimal dose of *Mycoplasma hyopneumoniae* strain 116 required to induce pneumonia in SPF pigs. Journal of Applied Microbiology 108, 1523–1533.

Meyns, T., Maes, D., Dewulf, J., Vicca, J., Haesebrouck, F., de Kruif, A., 2004. Quantification of the spread of *Mycoplasma hyopneumoniae* in nursery pigs using transmission experiments. Preventive Veterinary Medicine 66, 265–275.

Meyns, T., Dewulf, J., de Kruif, A., Calus, D., Haesebrouck, F., Maes, D., 2006. Comparison of transmission of *Mycoplasma hyopneumoniae* in vaccinated and non-vaccinated populations. Vaccine 24, 7081–7086.

Meyns, T., Van Steelant, J., Rolly, E., Dewulf, J., Haesebrouck, F., Maes, D., 2011. A cross-sectional study of risk factors associated with pulmonary lesions in pigs at slaughter. The Veterinary Journal 187, 388–392.

Segales, J., Valero, O., Espinal, A., Lopez-Soria, S., Nofrarias, M., Calsamiglia, M., Sibila, M., 2012. Exploratory study on the influence of climatological parameters on *Mycoplasma hyopneumoniae* infection dynamics. International Journal on Biometeorology 56, 1167–1171.

Sibila, M., Pieters, M., Molitor, T., Maes, D., Haesebrouck, F., Segales, J., 2009. Current perspectives on the diagnosis and epidemiology of *Mycoplasma hyopneumoniae* infection. The Veterinary Journal 181, 221–231.

Vangroenweghe, F., Labarque, G.G., Piepers, S., Strutzberg-Minder, K., Maes, D., 2015. *Mycoplasma hyopneumoniae* infections in peri-weaned and post-weaned pigs in Belgium and The Netherlands: prevelance and associations with climatic conditions. The Veterinary Journal 205, 93-97.

Villarreal, I., Vranckx, K., Duchateau, L., Pasmans, F., Haesebrouck, F., Jensen, J.C., Nanjiani, I.A., Maes, D., 2010. Early *Mycoplasma hyopneumoniae* infections in European suckling pigs in herds with respiratory problems: Detection rate and risk factors. Veterinarni Medicina 55, 318–324.

Poster presentations

BAYESIAN ESTIMATION OF TRUE PREVALENCE FROM APPARENT PREVALENCE IN R: INTRODUCING THE 'PREVALENCE' PACKAGE

Brecht Devleesschauwer, Paul Torgerson, Johannes Charlier, Bruno Levecke, Nicolas Praet, Sophie Roelandt, Suzanne Smit, Pierre Dorny, Dirk Berkvens, Niko Speybroeck
brechtdv@gmail.com

Diagnostic tests are crucial tools in many epidemiological studies. However, due to imperfect sensitivity and/or specificity, these tests provide biased estimates of the true prevalence. Based on prior knowledge about the test characteristics, however, it becomes possible to estimate the true prevalence from the apparent prevalence. To this end, a Bayesian approach is considered most appropriate, as it is able to flexibly incorporate such prior knowledge in the estimation process.

Different Bayesian models have been proposed in the literature to estimate true prevalence from apparent prevalence. However, the application of these models has remained cumbersome, as there are no tools available that implement them. Researchers have therefore been compelled to derive and develop their own models, most often in spread sheet documents or in Bayesian software such as WinBUGS and OpenBUGS. This approach is error-prone, and hampers transparent and reproducible research.

To address this gap, we developed the 'prevalence' package, available in R, the dominant environment for statistical programming. As R, the 'prevalence' package is freely available and open-source. The package currently provides functions for the Bayesian estimation of true prevalence from individual samples tested with a single test; pooled samples tested with a single test; and individual samples tested with multiple tests. A variety of numerical and graphical diagnostics are available to assess model fit and convergence. The package further provides functionalities to establish prior Beta and Beta-PERT distributions for test sensitivity and specificity based on expert opinion. Work is in progress to develop functions for dealing with clustered samples and for including covariates in the different models.

By combining a variety of established methodologies for model fitting and evaluation, the 'prevalence' package provides a harmonized and comprehensive environment for true prevalence estimation. We therefore hope that the 'prevalence' package may become a useful tools for veterinary epidemiologists.

TOOL FOR EPIDEMIOLOGICAL MONITORING OF RUMINANT INFECTIONS IN WALLONIA

E. Dion, L. Delooz
ARSIA

Livestock agriculture needs to be reactive and pro-active against sanitary problems that must be detected as soon as possible to take adequate measures. DESIR (Dispositif Epidémiologique de Surveillance des Infections des Ruminants) is a dynamic tool for epidemiological monitoring of ruminant infections designed for the southern part of Belgium by the Regional Association for Animal Registration and Health (ARSIA) for veterinary practitioners. The tool tries to be consistent with the needs of the sector.

The aim of this tool is to give them sanitary information about livestock in real time based on herd's indicators combining population/movements data (no specific health indicators), necropsies, analysis results realised in our lab and others epidemiological observations collected by surveys (field observations), literature,…

Veterinarian will be able to consult indicators of herds for which they are linked by an epidemiological surveillance contract. They will also be informed over relative levels of these herds with respect to regional results about observed health trends, alerts, ...

Data from several databases will be compiled, analysed and interpreted. Information will be available for each veterinary and shown in comprehensive and visual personal dashboard. Veterinary will be able to use epidemiological information in his daily practice.

INVESTIGATION OF A POSSIBLE LINK BETWEEN VACCINATION AND THE 2010 SHEEP POX EPIZOOTIC IN MOROCCO

Andy Haegeman, Khalil Zro, Frank Vandenbussche, Donal Sammin, MM Ennaji, Annebel De Vleeschauwer, Kris De Clercq
CODA/CERVA

Objective:
Sheep pox is endemic in most parts of Northern Africa and has the potential to cause severe economic problems. Live attenuated vaccines are used in Morocco, and in many other countries, in order to control the disease. Sheep pox virus (SPPV) re-appeared in 2010 causing a nodular clinical form previously not observed in Morocco. The severe clinical signs observed during the course of this outbreak and initial reports citing similarity in nucleotide sequence between the Moroccan vaccine strain and field isolates warranted a more in depth analysis of this epizootic. It was the purpose of this study to (1) look more closely into the epizootic of 2010 in Morocco (2) investigate the possible link between the Moroccan vaccine used in that period and the virus isolated from the field by exploring sequence similarity in different regions of the genome and by developing PCR methods to differentiate between vaccine and wild-type virus.

Methods:
Samples collected from 19 flocks located within four provinces the eastern region of Morocco during the 2010 Outbreak were analysed using real-time PCR panel and an in-house monolayer Elisa. Isolates from different geographic regions were phylogenetically analysed and compared to each other and to the vaccine used in the region. DIVA PCRs were developed to analyze a possible link between the isolates and vaccine.

Results:
Aside from scab material, blood was the sample type which most frequently gave a positive result (98% positive) followed by buccal and ocular swabs, 93% and 91% positive, respectively. However, most variability was seen in blood samples when using the Haegeman PCR panel, ranging from 64%, 69% to 85% positivity. Seroconversion for Capx was detected in 80.5% of the animals and in each flock.
Sequence analysis of two genomic regions showed that all isolates obtained from four the provinces of Eastern Morocco were identical and were clearly different from the Moroccan vaccine strain. Using two newly developed DIVA PCRs no trace of wild type SPPV was found in the vaccine and no trace of the vaccine was found in the sampled animals.

Conclusion:
Supporting the published findings ocular swabs were found to be a useful sample type to test with a detection rate of the Haegeman PCR-panel of 91%. For rectal and nasal swabs the detection rates were noticeably probably due to a greater sensitivity to the timing of sampling relative to the course of infection. Buccal swabs (detection rate of 93%) were found to be an interesting alternative with the added advantage of being easier to take than ocular swabbing. The PCR-panel detection rate in blood was found to be 98%. However, this sample type may be less suited as the individual PCR detection rates of the PCR-panel were more variable.
Based on the sequences data from the different isolates, it can be stated that a single SPPV strain was responsible for the 2010 epizootic. In addition, no evidence was found linking the vaccine (vaccine strain or presence of wild type virus) directly to the epizootic. However, further analysis is needed to clarify the epidemiological picture in relation to recombination, re-introduction or re-emergence. The two newly developed PCRs, able to differentiate between the RM-65 vaccine strain and wild type SPPV, can be a useful tool in future epidemiological investigations during vaccination programs.

EVALUATION OF THE EFFECT OF ADMINISTRATION AND TREATMENT DOSE ON FLUOROQUINOLONE RESISTANCE IN E. COLI IN BROILERS

Ilias CHANTZIARAS[1,2] Filip BOYEN[2] Annemieke SMET[2] Jeroen DEWULF[1]
Faculty of Veterinary Medicine, Ghent University

Objective:
Four experimental studies were performed to study the effect of treatment dose (proper-dose, half-dose, double-dose) and route of administration (oral, intramuscular) with enrofloxacin on fluoroquinolone resistance in E. coli in broilers. For the first two studies we made use of a bacteriologically-fit enrofloxacin-resistant inoculation strain. In the latter two studies, we made use of a bacteriologically non-fit strain.

Materials and Methods:
As soon as all chicks were hatched in a sterile environment, they were inoculated with a mixture of an enrofloxacin-resistant E. coli strain (also rifampicin-resistant) and a reference E. coli strain (rifampicin-resistant, enrofloxacin-susceptible) (experiment 1 & 3: inoculum ratio 100:1, experiment 2 & 4: 1:100). In total, 180 individually numbered- chicks were used (45 for each experiment). In each experiment, 6 samplings were performed (day 3, 6, 9, 12, 15, 22). All treated groups received enrofloxacin for 3 consecutive days (day 6-8). The percentage of enrofloxacin-resistant E. coli colonies compared to the overall E. coli colonies was determined for each chick.
Linear mixed models were used to evaluate the effect of treatment and the effect of treatment dose and route of administration on fluoroquinolone resistance in E. coli in broilers.

Results:
In the experiments with the bacteriologically-fit enrofloxacin-resistant strain and the inoculation ratio 100resistant: 1susceptible (in the inoculation dose) no significant effect of treatment ($p = 0,27$), administration route ($p = 0,36$) and dose ($p = 0,06$) was observed. In the second experiment with the bacteriologically-fit strain and the inoculation ratio 1resistant : 100susceptible, the effect of treatment was significant ($p < 0,01$) (more resistance with treatment), whereas the effects of administration route ($p = 0,07$) and dose ($p = 0,15$) were not significant.
In the experiments with the bacteriologically-non-fit enrofloxacin-resistant strain and the inoculation ratio 100resistant: 1susceptible, the effect of treatment ($p < 0.01$) (more resistance with treatment), was significant, whereas the effect of administration route ($p = 0,06$) and dose ($p=0,99$) were again not significant. In the last experiment with the bacteriologically-non-fit strain and the inoculation ratio 1resistant: 100susceptible, the effects of treatment ($p < 0,01$) (more resistance with treatment) and administration route ($p < 0,01$) (more resistance with oral treatment) were significant. The effect of dose was not significant ($p = 0,27$).

Conclusions:
Treatment dose, administration route and even the treatment itself with enrofloxacin did not influence the proportion of resistant/susceptible strains in the gut of chickens carrying a high number of bacteriologically-fit enrofloxacin resistant bacteria before onset of the treatment. When the chicks were inoculated with a low dose of bacteriologically-fit resistant bacteria, treatment did select for the presence of the resistant strain. However, there was no significant effect on selection pressure related to the treatment dose or the administration route.
In the experiments with the bacteriologically non-fit strain, treatment did select for the presence of the resistant strain. In the combination of bacteriologically non fit and an inoculation with a low proportion of resistant bacteria, the oral route selected more for the presence of the resistant strain compared with the parenterally-treated group. On both experiments, again there was no significant effect on selection pressure when the treatment dose was doubled or halved.

THE RISK OF CROSS-CONTAMINATION DUE TO THE USE OF ANTIMICROBIAL MEDICATED FEED THROUGHOUT THE TRAIL OF FEED FROM THE FEED-MILL TO THE FARM

Filippitzi M. E., Sarazzin S., Dewulf J.
Veterinary Epidemiology Unit, Department of Reproduction, Obstetrics and Herd Health, Faculty of Veterinary Medicine, Ghent University

The cross-contamination of supposedly non-medicated feed with residues of antimicrobial compounds causes a public and animal health concern associated with the potential for selection and dissemination of resistance in commensal bacteria and potentially zoonotic bacteria. To identify the extent of this situation, we built a model that provides a way to estimate the level of cross-contaminated feed in total and per different levels at which cross-contamination may occur (i.e. the feed-mill, the transport truck, the farm), for different levels of antimicrobial medicated feed produced in a country per year.

The model, which was built at @Risk®, estimated that, given our assumptions, when a hypothetical level of xi=2% of the feed produced in a country per year (i.e. 2% represents the situation in Belgium) is antimicrobial medicated feed, C1i= 5.1% of the total feed produced in a year (T1i) could be cross-contaminated with different levels of antimicrobials due to practices related to medicated feed, with a high uncertainty. In detail, 1.8% of T1i in such a country would be due to cross-contamination occurring at the feed-mill level, 1.6% at the transport truck level and 1.7% at the farm level. The level of cross-contaminated feed produced in a country per year when xi=2% was found to have a mean value of C2i= 3.3% of T1i when medicated feed is produced in end-of-line mixers and C3i= 2% of T1i when fine dosing system (FDS) trucks are used. These figures showed a 31% reduction in cross-contamination levels due to scenario 1 and a 59% reduction due to scenario 2, from the baseline scenario considering all pathways.

Based on a number of assumptions and calculations, the model showed that a non-negligible level of the total feed produced in a country in a year can get cross-contaminated with various low concentrations of antimicrobials right after the production, delivery and storage of medicated feed, when a hypothetical 2% of the total feed produced is antimicrobial medicated feed. The model also demonstrates that even in cases where the aforementioned scenarios would be actually implemented, the risk would not be completely removed given that sources of cross-contamination also still exist at the truck and farm levels and hence should not be overlooked. This shows that the risk, being the result of factors occurring at different levels, is hard to be fully removed and thus, the use of medicated feed should be avoided as much as possible.

ANTIMICROBIAL USE, ANTIMICROBIAL RESISTANCE AND BIOSECURITY ON FLEMISH BROILER FARMS: PRELIMINARY RESULTS OF THE EFFORT PROJECT

M. Schlepers, J. Dewulf
Veterinary Epidemiology Unit, Department of Reproduction, Obstetrics and Herd Health, Faculty of Veterinary Medicine, Ghent University

The **EFFORT** (Ecology from Farm to Fork Of microbial drug Resistance and Transmission) project studies the complex ecology of antimicrobial resistance (AMR) and the interactions between bacterial communities, commensals and pathogens in animals, the food chain and the environment. As part of the EFFORT project, randomly selected broiler farms were visited to gather data on antimicrobial use, biosecurity, technical results and animal welfare. Antimicrobial use was quantified as TI (treatment incidence) based on the DDDA (defined daily dose animal) over a 365-day period and the risk-based biocheck.ugent system was used to score the biosecurity. Moreover, 25 fecal samples were collected to analyze for AMR of Escherichia coli. The preliminary results regarding antimicrobial use, AMR and biosecurity of 16 broiler farms will be discussed.

The TI ranged between 2.84 and 28.25 with a mean of 12.19 per 1,000 animal days. This indicates that an average broiler is treated 1.22% of its lifetime with antimicrobials. AMR at herd level varied largely between the different herds and the different antimicrobials tested: ampicillin 77% (20%-100%), cefotaxime 12% (0%-80%), ceftazidime 11% (0%-60%), meropenem 0% (0%-0%), ciprofloxacin 56% (3%-100%), nalidixic acid 50% (3%-90%), chloramphenicol 23% (0%-60%), colistin 0% (0%-0%), gentamicin 5% (0%-50%), sulfamethoxazole 63% (10%-100%), trimethoprim 52% (10%-90%), tetracycline 54% (0%-90%) and tigecycline 0% (0%-0%). The internal biosecurity score was on average 66 and the external score 65.

The final analyses will examine the possible associations between antimicrobial use, AMR and biosecurity score and will be performed as soon as the last four broiler farms are visited.

YEARLY AND SEASONAL EVOLUTIONS IN PERFORMANCE PARAMETERS OF BELGIAN SOWS IN 2011-2013

Marlijn Klinkenberg, Tommy van Limbergen, Jeroen Dewulf, Dominiek Maes
Ghent University, Faculty of Veterinary Medicine, Department of Reproduction, Obstetrics and Herd Health
Unit Porcine Health Management

Introduction: This study was conducted as part of the EU-funded PROHEALTH project. Performance parameters of sows are mainly used to provide a quick overview of the on-farm situation, economically and technically. Over the last decades the efficiency of reproduction in breeding herds has significantly improved. However, no recent studies on performance parameters were published in Belgium, which included the amount of herds described in this study (46 herds).
Aim: The aim of this study was to investigate if in the previous years (2011, 2012 and 2013) there are still evolutions going on and if a seasonal effect can be seen on different performance parameters in Belgium.
Materials and method: In this study, performance parameters of 46 pig herds were used to get a national overview. Data were provided by a herd management software company. Clients of this company had to give their consent before their information was used. All parameters (monthly averages) were registered at herd level.
Results: A linear mixed model was used, with year or month as fixed effects and farm and farm size as random effects. A SIDAK correction was done. Results were significant when the p-value was < 0.05. The overall results (2011, 2012 and 2013) are given in the table below. Statistical analysis was done in IBM SPSS statistics 22

Table 1. Overall results 2011-2013

Parameter	Overall mean (sd)
Herd size (n sows)	326 (187)
Average parity	2.91 (0.57)
Repeated breedings (%)	8.24 (5.84)
Gestation length	115.19 (0.82)
Litters (n)/sow/year	2.38 (0.12)
Live born piglets (n)	13.38 (1.98)
Still born piglets (n)	1.20 (0.49)
Weaned piglets (n)	11.61 (1.33)
Weaned (n)/sow/year	27.70 (3.84)
Piglet mortality (%)	13.12 (4.34)
Sow culling rate (%)	4.20 (2.12)

Significant seasonal (monthly) evolutions:
- Average percentage of repeated breeding's was significantly higher in September (10.03%) compared to January till July (mean 7.95%).
- Average number of weaned piglets was significantly lower in January (11.29) compared to May till October (mean 11.68).
- Average production number (weaned piglets per sow per year) was significantly lower in January (26.67) compared to May till October (mean 27.78).
- Average piglet mortality was significantly higher in November (14.0%) compared to June (12.6%).

Significant evolutions over the years 2011-2013:
- Average number of still born piglets was significantly lower in 2011 (1.14) than in 2012 (1.22) and 2013 (1.24).
- Average gestation length in 2011 (115.16) was significantly shorter than in 2013 (115.23).
- Average percentage of repeated breedings showed a significant increase in 2012 (9.15%) compared to 2011 (7.91%) and 2013 (7.65%).

Conclusion: A clear effect could be seen in percentage of repeated breedings in September, probably due to seasonal infertility in sows. The effect of seasonal infertility is influenced by temperature and photoperiod. This problem currently still plays a role on the sow farms. This is consisted with other findings in literature. A consequence of the higher amount of repeated breedings in September could be the lower number of weaned piglets in the beginning of the following year. This has not been described in literature, however a smaller litter size is.
Also some significant trends were seen during the three consecutive years. The number of still born piglets increased. This could be explained by the increased number of live born piglets in the same year (figure 3 poster), however, these results were not significant. For the parameters piglet mortality and gestation length, no definite explanation can be given yet. Further research in the scope of the PROHEALTH project will study the possible influence of management and housing of the individual farms on performance parameters on sow farms

ASSOCIATION BETWEEN BIOSECURITY, HERD CHARACTERISTICS, PRODUCTION PARAMETERS AND ANTIMICROBIAL USAGE IN PIG PRODUCTION IN FOUR EU COUNTRIES

Merel Postma, Annette Backhans, Lucie Collineau, Svenja Loesken, Marie Sjölund, Catherine Belloc, Ulf Emanuelson, Elisabeth Grosse Beilage, Katharina D.C. Stärk and Jeroen Dewulf, on behalf of the MINAPIG consortium
Veterinary Epidemiology Unit, Department of Reproduction, Obstetrics and Herd Health, Faculty of Veterinary Medicine, Ghent University

Background
Disease prevention is an import factor in the reduction of antimicrobial usage, a highly debated problem in current animal production, related to antimicrobial resistance and public health concerns. An improved biosecurity status might be one of the actions that could improve overall health status and reduce the necessity of antimicrobials in pig production.

Objective
Assessing associations between level of biosecurity, herd characteristics, production parameters and antimicrobial usage level, in order to advise on best practices for a low antimicrobial usage level with maximum pig health and production.

Materials and Methods
227 farrow to finish herds in Belgium, France, Germany and Sweden were visited in 2013 within this cross-sectional study. Information was collected on biosecurity status (www.biocheck.ugent.be), antimicrobial usage (www.abcheck.ugent.be), herd characteristics (e.g. farrowing rhythm) and production parameters (e.g. daily weight gain).

Results
The level of internal and external biosecurity were related to each other. The higher the external biosecurity the more weaned piglets per sow per year and a lower antimicrobial usage from birth till slaughter. A longer farrowing rhythm, vaccination against less pathogens or weaning at a later age resulted also in a lower usage.

Discussion and Conclusion
Biosecurity can improve production results most likely because of improved animal health. At herds with a high disease pressure more vaccines were used and subsequently also more antimicrobials. When weaning at a later age piglets might have developed a better immunity and will be more resilient against pathogenic threats.

Perspectives
This study showed that a reduction in antimicrobial usage from birth till slaughter in pig production could be achieved by using a longer farrowing rhythm, weaning of the piglets at an older age and improvement of the biosecurity status. Policy makers, herd advisors and farmers should benefit from this knowledge in order to reduce the antimicrobial usage on pig herds.

IMPROVING LABORATORY DIAGNOSTIC CAPACITY OF EPIZOOTIC DISEASES IN BELGIUM

Cargnel Mickaël
CODA/CERVA

Belgium and other European neighbouring countries have faced over the last decade several (re-)emerging diseases as well as zoonotic diseases. It has been noticed that during these episodes, the laboratory diagnostic capabilities were surpassed, which led to an increase in the time required for the control or eradication of these diseases. Belgium is a European hub and can be affected by these diseases which can enter via different paths e.g. trade of live animals or animal products from around the world or via wildlife migration. It is therefore crucial to react rapidly to these diseases, to establish clear and comprehensive contingency plans to develop appropriate diagnostic tests. Moreover, there are only few publications looking at the issues of increased laboratory diagnostic capacities for epizootic diseases based on.

First of all, a systematic literature review, based on the OIE reference manual as well as publications in PubMed and CAB abstract were consulted. Keywords and Boolean operators with relation to diagnostic assays were used in order to establish and map existing techniques. For each of them, the matrix, target (specific antibody, antigen…) sensitivity (relative and/or diagnostic), diagnostic specificity, time lag to detect antigen/antibodies, the main advantages/disadvantages, the capacity to quantify the target, the cost per sample and the different application(s) of the assay were extracted and defined.

Results show that virus isolation and virus neutralization test are sensitive and specific and are therefore often considered as gold standard confirmation tests. However, they are slow, laborious and require laboratory facilities. For many diseases, enzyme-linked immunosorbent assays (ELISA) are often used. Although its rapidity, often good sensitivity and specificity, ELISA needs to be standardized which requires training and experience. Molecular methods such as the polymerase chain reaction (PCR or mostly real-time PCR) are very specific and sensitive which give qualitative and/or quantitative result in a few hours but need fresh and adequate material (e.g. good extraction protocol). In addition, PCR's are very often sequence-dependent and thus sensitive to mutations and contamination which can lead to false negative results. Sequencing offers promising solutions but is still restrained for research purposes because of the price for the equipment, the sample preparation and the requirement for trained staff.

A large survey in Belgium and abroad has been completed to implement this database and to determine laboratories' capacities in Europe. Using the LimeSurvey® web application, twelve of the most frequent assays selected from the literature review were submitted to all major Belgian laboratories. For each of them, the same data discussed in the literature review was asked and additionally the commercial brand of the assay (if relevant), the capacity in routine as well as in crisis situations, the process duration (routine/crisis) and the degree of accreditation. Also bilateral partnership (techniques and/or collaboration protocols) between CODA-CERVA and other European institutions will be developed. Finally, the evaluation of diagnostic capabilities achievements for each disease using four scenario analysis (testing during import, , screening in sentinel animals, mass screening and proving freedom of infection) and a diagnostic flow chart will be proposed to optimize detection.
This work will help the Veterinary Authorities to take a faster, precise and well documented decision in case of an epidemic in Belgium.

TBEV SEROPREVALENCE AND TEST ACCURACY IN FLEMISH WILD BOAR.

Sophie Roelandt, Vanessa suin*, Yves Van der Stede, Sophie Lamoral, Sylvie Marche, Marylène Tignon, Jim Casaer, Bernard Brochier, Steven Van Gucht, Stefan Roels, and Muriel Vervaeke.*
CODA/CERVA

The risk of TBEV-introduction into Belgium remains high and the presence of seroconverted wildlife and domestic animals in Belgium has already been demonstrated in multiple studies. In the frame of a Flemish wildlife surveillance in 2013, a serological screening was performed on sera from Flemish wild boar (n=238) in order to detect TBEV-specific antibodies. These sera were taken in 2013 throughout the whole Flemish wild boar population range.

All samples were subjected to gold standard TBEV seroneutralisation (SNT). Seven wild boar were seropositive and showed moderate to high SNT-titers - three had borderline results. Seroprevalence was estimated around 4.20% (95%CI: 1.65-6.75%). Other Flaviviridae (Classical Swine Fever, West Nile Fever, Louping Ill) were ruled out and thirteen available tonsils tested negative in TBEV RT-PCR.

The test characteristics of a commercially available TBEV-ELISA were assessed against the gold standard results. Using the manufacturer's cut-offs and an alternately positive/negative interpretation of SNT-borderline results, the IgG protocol of this ELISA showed low diagnostic sensitivity and good diagnostic specificity (DSe: 40-57% and DSp: 91-92%). ELISA agreement with the SNT was judged "slight to fair". ROC-analysis showed that for early detection screening purposes (with SNT follow-up), the ELISA cut-off might be placed as low as low as 35 Vienna-units: this would result in improved DSe (70-71%) at the cost of DSp (64.04-69.74%).

This study showed the presence of TBEV-specific antibodies in wild boar and potential TBEV-foci in Flanders. Ongoing wild boar surveillance could serve as sentinel warning system for public/human health prevention. Additional active surveillance and direct testing are now recommended to attempt virus detection and to further determine the characteristics of endemic foci, while continued passive medical and veterinary surveillance is indicated to monitor the potential risk for Belgian public health.

SHORT AND SEMI-LONG TERM EVOLUTIONS IN BELGIAN BROILER'S PERFORMANCE, HEALTH AND WELFARE PARAMETERS.

Tommy Van Limbergen, Marlijn Klinkenberg, Johan Van Erum, Jeroen Dewulf, Richard Ducatelle, Dominiek Maes
Ghent University, Faculty of Veterinary Medicine

Introduction: Efficient broiler production is expressed by a number of zootechnical parameters. A good understanding and follow up of these parameters is critical in the optimization of individual flock health management and performance. The present study was performed in the scope of the ongoing EU-funded PROHEALTH project aiming to investigate the importance of production diseases in European pig and poultry production. The aim of this study was to investigate time-related effects and associations between different performance, health and welfare indicators in poultry.

Material and methods: The dataset on broilers contained historical information from 38 commercial broiler farms at flock level (417 flocks), and included in total 22 million broilers. Data quality was carefully checked, with detection of possible outliers. The different parameters were described per year (= year in which the grower-period started) and as an average for 2011-2013 (table 1). For each parameter, the mean (+/- standard deviation) is presented. Short term evolutions were based on the quarter (Q) in which day old chicks (DOC) were placed in the house. Long term evolutions were based on the year in which DOC were placed into the house.

All statistical analyses were performed with SPSS®, using linear mixed models and Spearman's correlations. Only significant correlations ($p < 0.05$) with a value > $|0.3|$ were taken into account. Correlations above $|0.6|$ were considered as strong correlations.

Results:

Table 1: Performance, health and welfare parameters on 417 broiler-flocks from Belgium.

Parameter	Overall	2011	2012	2013
EPI[1]	361 (37)	353 (32)	356 (38)	371 (37)
FCR[2]	1.65 (0.81)	1.68 (0.07)	1.66 (0.06)	1.61 (0.14)
FCR 1500[3]	1.30 (0.13)	1.32 (0.15)	1.32 (0.10)	1.26 (0.13)
Live weight (kg)	2.36 (0.16)	2.36 (0.12)	2.36 (0.12)	2.36 (0.22)
Age at slaughter(days)	35.60 (3.96)	39.28 (1.16)	39.97 (6.83)	39.54 (1.27)
ADG[4] (g/d)	60.27 (3.95)	60.32 (3.31)	59.98 (4.65)	60.47 (3.80)
Overall mortality (%)	3.21 (1.91)	3.73 (2.15)	3.18 (1.70)	2.83 (1.79)
Condemnation rate (%)	1.92 (2.04)	2.46 (2.31)	1.71 (1.81)	1.55 (1.87)
Flock-size	52 412 (24 402)	51 612 (23 153)	52 385 (24 148)	53 038 (25 988)

[1]European production index;[2]Feed conversion rate; [3]FCR, corrected for 1500g live-weight; [4]Average daily gain.

Short term effects were only found for EPI and FCR. Both parameters tended to be significantly better in Q4 in comparison with Q2. FCR during Q2 (1.66) was higher than during Q4 (1.65). EPI during Q4 (368) was also better than during Q2 (355). A positive trend in performance was observed with the EPI, as 2013 (371) was significantly higher than 2011 (353) and 2012 (356). The FCR was significantly lower in 2012 (1.66) and 2013 (1.61) compared to 2011 (1.68). There were no long term effects in the age of the broilers, average weight at slaughter, ADG, condemnation rate and FCR 1500. Overall mortality was significantly different between 2011 (3.73%) and 2013 (2.83%). Average age was significantly negatively correlated with ADG ($r = -0.49$) and EPI ($r = -0.38$). Average weight at slaughter seemed to be negatively correlated to FCR ($r = -0.39$) and FCR 1500 ($r = -0.73$), whereas positive correlations were found with EPI ($r = 0.66$) and ADG ($r = 0.77$). EPI was negatively correlated with FCR ($r = -0.70$) and FCR 1500 ($r = -0.79$), whereas it was positively correlated with ADG ($r = 0.83$). FCR 1500 was strongly correlated with FCR ($r = 0.86$) and ADG ($r = -0.71$). ADG was also negatively correlated with FCR ($r = -0.53$).

Discussion and conclusions: The results presented in this study are in accordance with other recent studies (Siegel, 2014;Tuyttens et al., 2014). Both performance (FCR and EPI) and health (overall mortality) parameters tended to improve in consecutive years. This suggests that broiler production in Belgium can still be improved, most likely by ongoing improvements in genetic selection and an overall flock health management. The obtained correlations were as expected, given the relation between the different zootechnical parameters. In the next stage of the PROHEALTH project protective and risk factors for production diseases will be investigated on these farms.

REDUCTION OF ANTIBIOTIC USE TO TREAT POST-WEANING DIARRHOEA FOLLOWING ORAL VACCINATION WITH ESCHERICHIA COLI F4: CASE REPORT

Vangroenweghe F.

Introduction - Post-weaning Escherichia coli diarrhea (PWD), also called post-weaning enteric colibacillosis, in pigs remains a major cause of economic losses for the pig industry, due to either piglet death, or poor weight gain in surviving piglets [1,2] . PWD typically causes mild to severe watery diarrhea between 5 and 10 days after weaning and is caused primarily by enterotoxigenic Escherichia coli (ETEC). The most common adhesins found on ETEC from PWD in pigs are associated with fimbriae F4 (previously called K88) and F18, while the predominant enterotoxins are heat-labile toxin (LT), heat-stable toxin a (STa), and heat-stable toxin b (STb). In addition to F4 and F18, other fimbrial adhesins, such as F5 (K99), F6 (987P), and F7 (F41), have been associated with PWD, but less frequently [3,4,5,6]. Recent data about the prevalence of F4-positive ETEC and F18-positive ETEC in Europe are scarce [4,6,7]. Data from other regions of the world (Asia, Oceania, North America, South America) indicate that F18-positive ETEC strains are more prevalent than F4-positive ETEC strains [5,8-16]. The presented case report shows the impact of vaccination on overall post-weaning piglet health following vaccination with a live avirulent E. coli F4 vaccine.

Case description – Since more than 2 years, a closed 400-sow farm in a 3-week batch management system suffered from extreme problems with post-weaning diarrhea. The clinical phase started already within 3 days post-weaning with high levels of mortality and massive use of in-feed and injectable antibiotics (Table 1). During that period, several preventive options have been applied, such as in-feed zinc oxide inclusion, treatment with colistin, lincomycin and enrofloxacin (all based on bacteriology and subsequent antimicrobial resistance patterns). Each weaning batch consisted of approximately 600 piglets, weaned at around 24-26 days of age. For facilitating the weaning process, 500 kg of weaning feed is applied for each weaning batch. Depending on the feed consumption throughout the first post-weaning days, the switch to the post-weaning diet is performed earlier or later. Following diagnosis of an ETEC F4 pathogen, responsible for post-weaning diarrhea, an oral vaccination with a live avirulent strain of E. coli (Coliprotec F4; Elanco Animal Health) 7 days before the clinical outbreak is performed at a dose of 2 ml per piglet, containing 1.3-8.0 x 108 bacteria. An antibiotic-free window of 3 days before and 3 days after vaccination is necessary for optimal immunological response following bacterial growth in the intestines. The following parameters were recorded for each group: # weaned piglets, # dead piglets (% mortality) d1-d10, # antibiotic injections, treatment incidence (TI; treatments per 100 piglets), % pens treated on total, day of switch to post-weaning diet,

Results – The main results of the case are given in Table 1.

Table 1. Measured parameters of case of chronic problems with post-weaning diarrhea before and after vaccination with an oral, live, avirulent *E. coli* F4 vaccine.

	Treatment group		
Parameters	Pre-vaccination batch	Batch 1 – post-vaccination	Batch 2 – post-vaccination
# weaned piglets	600	550	600
# dead (% mortality) d1-d10	28 (4.7%)	11 (2.0%)	3 (0.5%)
# antibiotic injections	1800	190	150
TI (treatments/100 piglets)	300	34.5	25
% pens injected on total	100%	75%	37.5%
Day of feed change	D8	D5	D6
# h treatment administration	6.0 h	2.0 h	1.5 h
# h vaccination	-	2.75 h	3.0 h

Discussion – This case report shows that following a correct diagnosis to confirm the presence of ETEC F4 in post-weaning diarrhea problems, vaccination with an oral live avirulent E. coli F4 vaccine shows improvement of several economically important parameters. There is a major decrease in piglet mortality (4.7% to 2.0-0.5%), combined with a reduced treatment incidence, resulting overall in better piglet quality with higher early post-weaning feed intake and less labour to the swine farmer. In conclusion, vaccination with an oral live avirulent E. coli F4 vaccine resulted in lower antibiotic use (90-93% reduction in TI) and no zinc oxide inclusion in combination with lower piglet mortality and overall better piglet quality.

DIAGNOSTIC OPTIONS FOR ESCHERICHIA COLI ASSOCIATED WITH POST-WEANING DIARRHOEA: WHEN TO USE WHAT TEST?

Vangroenweghe F., Coppe P., Vandenbroucke V., Van Driessche E., Luppi A.

Introduction - Post-weaning Escherichia coli diarrhea (PWD), also called post-weaning enteric colibacillosis, in pigs remains a major cause of economic losses for the pig industry, due to either piglet death, or poor weight gain in surviving piglets [1,2]. PWD typically causes mild to severe watery diarrhea between 5 and 10 days after weaning and is caused primarily by enterotoxigenic Escherichia coli (ETEC). The most common adhesins found on ETEC from PWD in pigs are associated with fimbriae F4 (previously called K88) and F18, while the predominant enterotoxins are heat-labile toxin (LT), heat-stable toxin a (STa), and heat-stable toxin b (STb). In addition to F4 and F18, other fimbrial adhesins, such as F5 (K99), F6 (987P), and F7 (F41), have been associated with PWD, but less frequently [3,4,5,6]. In order to obtain a rapid diagnosis, a new on-site test kit for field use has become available that can detect the most important adhesion factors (F4, F5, F6, F18 and F41) involved in PWD cases.

The objective of the present study is to determine the sensitivity, specificity and the potential use for this new tools in diagnosing F4-positive E. coli causing PWD in Belgium and The Netherlands.

Materials and methods - A total of 40 pig herds distributed in the Benelux showing clinical signs of PWD (sudden death, watery diarrhea, decreased feed consumption, dehydration, depression) were targeted from April till June 2015. Fecal samples were collected from diarrheic pigs in acute phase (preferably less than 48 hours of diarrhea) of a total of 5 piglets per farm and submitted to DGZ-Vlaanderen (Torhout, Belgium). Besides the PCR test on bacterial isolates of hemolytic and non-hemolytic E. coli, another test was performed on all fecal samples in order to compare the diagnostic results: lateral immunochromatography (LIC) test (Rainbow Piglet F4/F18; Bio-X, Rochefort, Belgium). Moreover, samples were isolated according to the specific procedure of the laboratory. The presence of virulence factors was analyzed by PCR at IZSLER (Istituto Zooprofilattico Sperimentale della Lombardia e dell'Emilia Romagna, Emilia Romagna, Italy). For that, extracted DNA from isolated strains were collected and tested for the presence of genes encoding for adhesins (F4, F5, F6, F18 and F41) and toxins (LT, STa, STb, Stx2e) using a multiplex PCR [7]. Results expressed as positive or negative for F4 and F18 for both tests (LIC, PCR) were pairwise compared with PCR results as the 'golden standard' in order to calculate both sensitivity and specificity of the rapid diagnostic tools.

Results – In total, 183 samples were collected according to the rules of the sampling protocol. Overall, the LIC resulted in 43 postive results for F4 and 43 positive results for F18. Bacteriology resulted in a total of 87 hemolytic E. coli strains and 88 non-hemolytic E. coli strains. Subsequent PCR on isolated hemolytic and non-hemolytic E. coli strains revealed 52 positive tests for F4 and 54 positive tests for F18. The sensitivity and specificity of the LIC as compared to PCR as the 'golden standard' are given in Table 1.

Table 1. Sensitivity and specificity of lateral immunochromatography (LIC) as compared to PCR as the 'golden standard'.

		PCR	
		Sensitivity	**Specificity**
Lateral Immunochromatography	**F4**	50%	87%
	F18	57%	91%

Discussion – In the present study, the expression of the adhesion factors F4 and F18 in the samples collected was evenly distributed based on the PCR results. However, the entire procedure for bacterial isolation and subsequent PCR reaction takes several days in order to obtain the result. Under field condition, it is therefore important to be able to perform a more rapid and reliable diagnosis using other tests such as the LIC. The results from the present study show that in case of negative results, the probability of having no adhesion factors expressed is quite high (Sp > 87% overall for F4 and F18). Taking into account the lower values obtained for the sensitivity, we have to keep in mind that not all positive results are detected as such. Nevertheless, the rapid on-site LIC can have its value for rapid diagnostics and with multiple samples per farm, keeping in mind that some positive results might be missed. Another aspect that has to be taken into account in the evaluation is that different aspects of the adhesion factor detection are compared, namely the real expression on the bacteria in case of the LIC, as compared to the genetic potential to express in the PCR test. Moreover, the PCR test post-culture is a major golden standard, whereas the LIC was developed for rapid practical use under field conditions. Overall, we can conclude that all tests have their strength and weaknesses that need to be taken into account when using them under specific circumstances.

PREVALENCE OF VIRULENCE FACTORS OF ESCHERICHIA COLI ISOLATED FROM PIGLETS WITH POST-WEANING DIARRHEA

Vangroenweghe F., Vandenbroucke V., Van Driessche E., Luppi A.

Introduction - Post-weaning Escherichia coli diarrhea (PWD), also called post-weaning enteric colibacillosis, in pigs remains a major cause of economic losses for the pig industry, due to either piglet death, or poor weight gain in surviving piglets [1,2] . PWD typically causes mild to severe watery diarrhea between 5 and 10 days after weaning and is caused primarily by enterotoxigenic Escherichia coli (ETEC). The most common adhesins found on ETEC from PWD in pigs are associated with fimbriae F4 (previously called K88) and F18, while the predominant enterotoxins are heat-labile toxin (LT), heat-stable toxin a (STa), and heat-stable toxin b (STb). In addition to F4 and F18, other fimbrial adhesins, such as F5 (K99), F6 (987P), and F7 (F41), have been associated with PWD, but less frequently [3,4,5,6]. Recent data about the prevalence of F4-positive ETEC and F18-positive ETEC in Europe are scarce [4,6,7]. Data from other regions of the world (Asia, Oceania, North America, South America) indicate that F18-positive ETEC strains are more prevalent than F4-positive ETEC strains [5,8-16].
The objective of the present study is to determine the prevalence of both F4-positive and F18-positive ETEC causing PWD in Belgium and The Netherlands.
Materials and methods - A total of 208 pig herds distributed in the Benelux (Belgium, n=133 and The Netherlands, n=75) showing clinical signs of PWD (sudden death, watery diarrhea, decreased feed consumption, dehydration, depression) were targeted from January 2014 till June 2015. Rectal swab samples from diarrheic pigs in acute phase (preferably less than 48 hours of diarrhea) and/or ileum swab samples at necropsy of a total of 5 piglets per farm were collected and submitted to DGZ-Vlaanderen (Torhout, Belgium). Samples were isolated according to the specific procedure of the laboratory. The presence of virulence factors was analyzed by PCR at IZSLER (Istituto Zooprofilattico Sperimentale della Lombardia e dell'Emilia Romagna, Emilia Romagna, Italy). For that, extracted DNA from isolated strains were collected and tested for the presence of genes encoding for adhesins (F4, F5, F6, F18 and F41) and toxins (LT, STa, STb, Stx2e) using a multiplex PCR [17]. In addition, a total of 136 hemolytic Escherichia coli strains isolated from pigs with clinical signs of PWD from different pig herds in Belgium that were presented at the DGZ-Vlaanderen (Torhout, Belgium) for necropsy during 2014 were included in the study and tested by PCR (IZSLER, Italy).

Results – From January 2014 till June 2015, 35 non-hemolytic and 246 hemolytic E. coli strains were isolated from rectal swabs of diarrheic pigs (n = 75 farms) and 136 hemolytic E. coli strains were collected from the necropsy study (n = 133 farms). Results of the presence of genes encoding for adhesins (F4, F18) and toxins (LT, STa, STb) are given in Table 1. The prevalence of the different pathotypes was as following: ETEC F4 (52.6%) and ETEC F18 (32.5%). Other pathotypes such as ETEC F5 (2.0%) and ETEC F6 (1.0%) were only occasionally detected. Besides ETEC, a significant number of STEC pathotypes (n = 23; 11.9%) was also detected. The most prevalent virotypes in the necropsy study in Belgium are F4STaSTb (24.1%), F18STaSTb (8.2%), F4STaSTbLT (6.9%) and F4STbLT (5.2%). In The Netherlands, the most prevalent virotypes are F18STaSTb (26.5%), F4STbLT (18.4%), F4STaSTbLT (16.9%) and F4LT (10.3%).

Table 1. Prevalence of genes encoding for adhesions (F4,F18) and toxins (LT, STa, STb) in 74 hemolytic *E. coli* strains in Benelux.

	# isolates	% F4	% F18	% LT	% STa	% STb
Diarrheic swab study	282	55.9%	41.9%	51.5%	59.6%	74.3%
Necropsy study	135	44.8%	10.3%	31.0%	56.9%	63.8%

Discussion - This study confirms that the fimbriae type F4 is more prevalent than F18 among E. coli isolates from PWD cases in Belgium and The Netherlands. ETEC strains were involved in nearly 87% of the cases investigated. Laboratory diagnostics, including characterization of virulence factors, are essential to understand the role of E. coli in PWD outbreaks and initiate appropriate preventive and control measures such as oral vaccination.

VEE studiedagen

1993 Epidemiologie en economie in de veehouderij - St. Niklaas

1994 Economische aspecten van dierziektenbestrijding – Klassieke varkenspest: de sector en het beleid – St. Niklaas

1995 Residuen bij antibioticagebruik – Actuele bestrijdingsprogramma's – St. Niklaas

1996 Preventie van overdracht van zoönosen via voedsel door bewaking van de productieketen – Deinze

1997 Biologie en management bij het uitbreken van dierziekten – Boxtel NL

1998 Epidemiologische aspecten van de bedrijfsbegeleiding – Gent

1999 Bedreiging van insleep van ziekten uit de derdewereldlanden, detectiesystemen en economische implicaties – Antwerpen

2000 Preventie van besmetting in de voedselketen – Brussel

2001 Risicoanalyse en kwaliteitsbeheer van de dierlijke producten – Melle

2002 Risk-assessment: dierziekten en bewaking voedselketen – Leuven

2003 Antibioticumresistentie bij landbouwdieren – Torhout

2004 Nieuwe toepassingen van de epidemiologie en de economie in de dierengezondheidszorg – Melle

2005 Survey methodologie – Diepenbeek

2006 De rol van observationele studies bij het identificeren van risicofactoren – Gent

2007 Lustrumviering VEE <> VEEC – Emerging diseases – Wageningen (NL)

2008 Economische gevolgen van infectieziekten bij landbouwhuisdieren: Hoe belangrijk zijn ze? – Leuven

2009 Epidemiologische tools als hoeksteen voor beleid en praktijk – Tervuren

2010 Eradicatie van endemische dierenziekten: hoe ver moeten we gaan? – Roeselare

2011 Is prevention better than surveillance? – Sint-Niklaas

2012 VEE en VEEC organiseren ISVEE 13 in Gent en Maastricht

2013 Impact of globalization on animal health – Drongen

2014 Meeting AESA & VEE - Brussel

2015 Evidence Based Veterinary Medicine - Melle