Focus Group
Animal husbandry

February 3rd – 4th, 2014 – Barcelona, Spain

eip-agri
AGRICULTURE & INNOVATION

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EIP AGRI Focus Group on animal husbandry

Starting paper prepared for the second meeting – Barcelona

STARTING PAPER

1 - Objectives of the focus group

The final aim of the focus group on animal husbandry is to identify cost efficient existing and innovative strategies to reduce the use of antimicrobials on pig herds. The group should also identify where the efforts must be put for further research activities that will provide practical sustainable solutions to antimicrobial use. To be more precise, this focus group is committed to address the following goals:

- Develop and explore integrated strategies to reduce the use of antibiotics on pig farms
- Take stock of the state of the art of best farming practices to protect health and welfare of the pigs, listing problems and opportunities
- Summarize possible solutions to the problems listed
- Take stock of the art of research for solutions to reduce antimicrobial usage
- Look at alternative treatments to antimicrobials and assess the consequences as regards to animal health and welfare and veterinary public health
- Identify needs from practice and propose directions for further research
- Assess the economic implications and veterinary aspects of integrated strategies
- Propose priorities for innovative actions to test solutions and opportunities (*e.g.* ideas for future operational group projects) and disseminate the practical knowledge gathered.

2 - Role of this paper

This paper intends to serve as a preparation for the discussions for the second meeting of the focus group. It gathers and sets order to the outcomes of the focus group's previous work and prepares the field for further development of the draft proposals on existing and innovative cost effective strategies to reduce antimicrobial usage on pig farms.

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3 - The first meeting

The first meeting for the EIP-AGRI Focus Group on animal husbandry was held on the 24th and 25th October 2013 in Eindhoven, The Netherlands. The topic of this first meeting was "how the use of antibiotic treatments in the pig sector can be reduced". The discussion was framed by the starting paper, which had been circulated to the group´s members in advance. An improved version of the starting paper of the first meeting is provided in the present paper (changes done according to the main suggestions of the members of the focus group are highlighted in yellow).

3-1. Starting paper:

Brief overview of strategies to reduce antimicrobial usage in pig production

Prof. Katharina Stärk, Dr.med.vet., PhD, DipECVPH and colleagues from the focus group

3-1.1. Introduction and background

Antimicrobials have been a key tool used to fight against infectious diseases since the 1940s. However, the efficacy of antimicrobials in human and livestock health is being increasingly threatened. Multiple reports have shown the increased costs and mortality rates associated with resistance. The World Health Organization (WHO) has recently classified antimicrobial resistance (AMR) as one of the top three threats to human health. Increased resistance to bacteria may indeed impair treatment efficacy and lead to therapeutic failures not only in human but also in animal populations. Hence, antimicrobial resistance has important issues in livestock production.

Resistance is a natural and ancient phenomenon, but there is evidence that the current global levels of resistance are*, in part*, due to the use of antimicrobials in livestock. Defining boundaries between the use of antimicrobials in humans and its use in animals proves extremely challenging. Any use of antimicrobials in animals can ultimately affect humans, and *vice versa*, due to the connectedness of micro-organism populations. Resistant bacteria and resistance genes carried by commensal bacteria in food-producing animals might reach people through several ways (*e g.* food chain, environment, direct animal contact…). The importance of these different contamination routes may vary according to livestock production systems. This paper aims to provide an overview of the problem and possible options to reduce antimicrobial usage in pig production. In order to avoid misunderstandings, a glossary of terms is provided at the end of the document. The terms "antimicrobials" and "antimicrobial resistance" are used to include all substances that might have public health impact keeping in mind that currently antibacterial resistance is most relevant.

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This paper is primarily directed at the focus group. The focus group is meant to explore ways to reduce the use of antimicrobials which have a positive or at least neutral effect on the economics of production and this will be focused on one type of livestock production: the pig sector. The present paper provides an overview of all available strategies, not all of which will fall in the focus category of the working group but are included for completeness. This particularly relates to the chapter on good governance**. It is anticipated that the focus group will consider changes in general farm and husbandry management practices that are most likely to lead to a reduced usage of antimicrobials. Practical consequences of such changes and the needs for innovative solutions to tackle the changes will also be considered.**

3-1.2. Brief problem description

Antimicrobials are widely used in human and animal medicine. The way they are used in livestock is related to the production systems in which the animals are kept. The overall quantities used depend on the species, production system and the common bacterial problems faced on a specific farm. There are 27 different antibacterial classes used in animals, most of which are also used in humans, but there are nine exclusively used in animals. In the livestock sector, antimicrobials can be used for **therapeutic purposes** (treatment of sick animals), **prophylaxis** (when antimicrobials are administered to a herd or flock of animals at risk of disease) or **methaphylaxis** (when antimicrobials are administered to clinically healthy animals belonging to the same flock or pen of animals with clinical signs). In the past, antimicrobials were also used for **growth promotion**, an application now banned in the EU. The goal was to decrease the time and total feed consumption needed to grow an animal to market weight. In the EU, growth promoting use of antimicrobials was discontinued in 2006; in the USA and most other parts of the world, growth promoters can still be legally used at present.

The effect of the use of an antibiotic in an animal is multidimensional. These drugs will not only affect the pathogen triggering the treatment, but have a general impact. Most public health and food safety concerns derive from the unintended effects of antimicrobials in the bacteria normally resident in the gastrointestinal tracts of food animals, the so-called microbiome. Additionally, the continued use of a specific antimicrobial can lead to resistance to multiple structurally related or unrelated antimicrobials, because the genes coding for this resistance are located on the same mobile genetic element (*e.g.* plasmids, transposons and integrons). In such cases, multiple resistance genes may be transferred in a single event. When two or more different resistance genes are physically linked, this is termed “co-resistance” (EMA, 2003). Selection for one resistance will therefore select for the other resistance gene(s) (EFSA, 2008). This amplifies the negative impact of antimicrobial use. Another negative impact lies in the fact that within an antimicrobial class, the target in the bacterial cell and the mode of action of the antimicrobial is the same or similar in each case. Some mechanisms of resistance will therefore confer resistance to most or all members of a class and the term “cross-resistant” is used (EMA, 2003). It may also occur in relation to unrelated classes, if the target overlaps or if the mechanism of resistance is of low specificity (EFSA, 2008).The direct consequences of resistance are treatment failure - potentially also for humans - and related reduced productivity of livestock as well as animal welfare

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issues. Considering these risks it is likely that public authorities will increasingly focus on the use of antimicrobials and further restrictions in their use may be introduced.

At the European level, to cope with this growing problem of antimicrobial resistance and the consequent treatment failures in humans and animals, the European Commission has established in 2011 an EU-wide plan[1] (EC, 2011a). This 5-year plan supplement previous actions and specificallyaims to combat antimicrobial resistance by using a holistic approach in line with the "One Health" initiative. The Commission's action plan against the rising threats from antimicrobial resistance contains 12 actions for implementation with EU member countries and identifies seven areas where measures are most necessary:

- making sure antimicrobials are used appropriately in both humans and animals
- preventing microbial infections and their spread
- developing new effective antimicrobials or alternatives for treatment
- cooperating with international partners to contain the risks of antimicrobial resistance
- improving monitoring and surveillance in human and animal medicine
- promoting research and innovation
- improving communication, education and training.

The Commission has compiled a detailed overview of the 12 actions covered by the action plan in a road map[2] including the operational objectives, the concrete activities and the deadlines.

The paper will now deal more in depth on strategies to reduce antimicrobial consumption in livestock, particularly in pig production.

3-1.3. Overview of strategies to reduce antimicrobial use in livestock

The World Organisation for Animal Health (OIE) and the European Commission (EC) as well as the WHO have described strategies to address the issue of antimicrobial resistance. The strategies can be summarised under the four following key headings (also see Figure 1):

1) Good governance and usage principles
2) Monitoring of usage and resistance
3) Unspecific prevention
4) Specific prevention

[1] http://ec.europa.eu/dgs/health_consumer/docs/communication_amr_2011_748_en.pdf
[2] http://ec.europa.eu/dgs/health_consumer/docs/road-map-amr_en.pdf

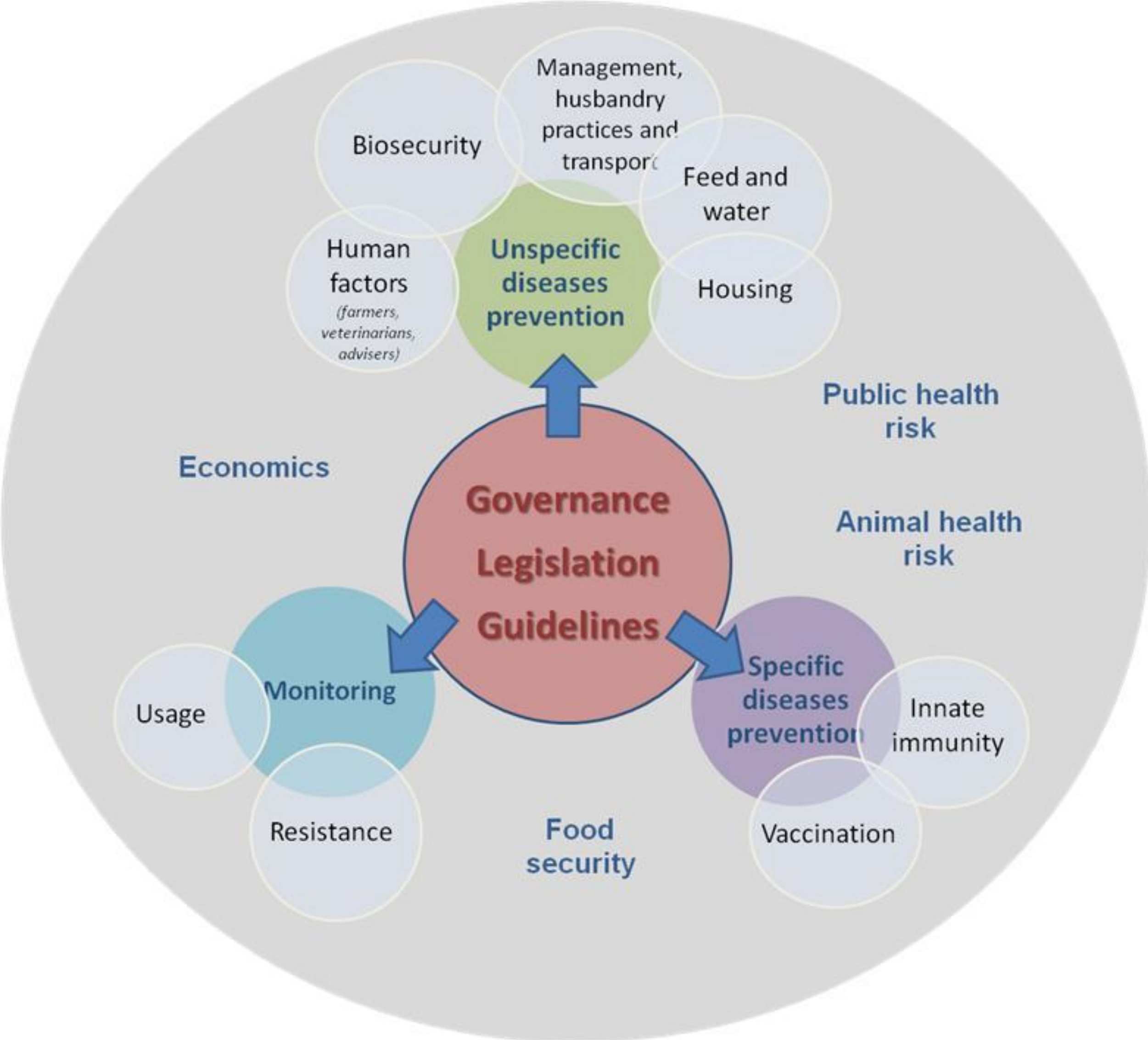

Figure 1: Overview of approaches to reduce antimicrobial usage in livestock

a) Good governance and usage principles

Good governance refers to the legal framework within which antimicrobials are used. It requires a legal process for registration of antimicrobial substances including documentation of effectiveness and safety. It also includes licensing of personnel involved in the sale and administration of antimicrobials, typically pharmacists and veterinarians, and sale conditions (e.g. prescription-only).

"**Prudent usage**" principles (sometimes also referred to as "responsible" or "judicious" usage) describe criteria for best practice in the context of antimicrobial use. Guidelines have been developed by a number of organisations including veterinary associations and stakeholder platforms. Prudent usage principles typically cover points of registration and legal basis, need for diagnosis, selection of appropriate substance, formulation and spectrum, correct dosage as well as emphasis on resistance testing. Some countries have developed more detailed usage guidelines based on these general principles. A significant fault in usage may occur in relation to the amount of a drug that is applied to an individual or group. There is substantial evidence of **over- and under**-usage of drugs in group treatments in poultry and pigs. The extent of such deviance from best practice and the extent of consequences on resistance development are currently not well understood, but accepted as a significant component in the prevention of resistance. Also, the impacts of specific delivery pathways, treatment durations and varying combinations of the two yet have to be systematically investigated. Thus prudent usage guidelines could become more evidence-based.

Private veterinarians usually earn their income by charging for their services and – in most countries – also by selling drugs directly to the producers. Even though decoupling prescription and delivery does not necessary result in a reduction of antimicrobial consumption (e.g. in Spain and Italy), such a situation should not be ignored when studying factors involved in the decision making process leading to antimicrobial usage.

b) Monitoring of usage and resistance

Several international organisations have formulated guidelines for the monitoring of both usage of antimicrobials as well as for monitoring resistance in micro-organisms. Regarding **usage monitoring**, there are significant differences in terms of the extent and methods used between countries, even at the European level as documented by the European Medicines Agency (EMA, 2013). In general, the comparison of usage data between countries should be treated with caution and conclusions should only be drawn with great care. Grave *et al*. (2010) compared the sales of veterinary antimicrobial agents between 10 European countries and found a wide variation between countries ranging from 18 to 188 mg/kg – mg of antibacterial drug sold/kg of biomass of slaughtered food animal. The authors concluded that the difference could not be explained only by differences in the animal species demographics. Speculative explanations include differences in animal husbandry practices. To facilitate data comparison, the European Surveillance of Veterinary Antimicrobial Consumption (ESVAC) has suggested the use of two standardized units of measurement[3]. Unless usage data are collected systematically and at sufficient level of detail, it will be difficult to make the link between frequency of usage and resistance. In the absence of this linkage, the utility of usage data remains limited.

The Netherlands, Belgium and France now all formally aim at reducing the total amount of antimicrobial usage, some with specific reduction targets expressed as percentage of usage reduction measured at the national level. Some countries intend to go one step further in that they aim to measure usage at individual farm level. A leader in the field of usage registration and reduction is Denmark, where the Danish Integrated Antimicrobial Resistance Monitoring and Research Programme (DANMAP) reports since 2005 not only on usage but also on the occurrence of antimicrobial resistance in zoonotic, indica-

[3]***Defined Daily Dose Animal*** (DDDA): This is an adaptation of the DDD used in human medicine, "the assumed average maintenance dose per day for a drug used for its main indications in adults". ***Defined Course Dose Animal*** (DCDA): This is a technical unit of measurement usually based on recommendations as described in antimicrobial product information and in some cases on information from experiments or scientific literature.

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tor and pathogenic bacteria from animals, food and humans. Denmark has recently also introduced usage reduction targets. Under this policy, a farmer receives a “yellow card” if he/she uses antimicrobials in a quantity two times higher than the national average. He/she then needs to take measures to reduce usage. This scheme has led to a reduction in antimicrobial use for therapy of almost 25% during the past two years. The Netherlands use a similar “traffic light” system.

Regarding the **monitoring of resistance** in micro-organisms, an EU-wide report is collated by EFSA and ECDC. Harmonized monitoring programmes for antimicrobial resistance in zoonotic and indicator bacteria have been established for this purpose. The data indicate that the pattern of resistance across countries and their livestock population varies. In the major pig producing areas of Germany, Spain, Denmark and Italy, *Salmonella* spp bacteria were found to have a high level of resistance to tetracyclines. Sweden and Finland were found to have no resistance.

c) Measures aiming at unspecific disease prevention

“Prevention is better than cure” is the EC’s motto in the animal health strategy. Preventive measures can either be specific (i.e. effective for a defined pathogen) or unspecific with general efficacy. The need for the use of antimicrobials is heavily influenced by the **environment** provided to the pigs, management **practices** and **husbandry** and their direct link to animal health. The better the husbandry and environmental conditions, the higher the general health status of the animals and the smaller the need for treatment. High-health schemes and pathogen-free production such as the specific pathogen free (SPF) programme provide sanitary protocols to manage both the risk of disease incursion as well as spread. The sanitary measures include access control, physical barriers for pets and wildlife as well as special hygiene protocols and sanitary monitoring of incoming pigs. In conventional husbandry systems, high-risk moments during the production cycle are generally known, for example, when new batches of young animals are added and/or mixed. Producers can anticipate certain periods of increased stress (e.g. movement/long trips of animals), where the probability of the development of clinical infections is increased. To help reduce the risk of clinical infections, animals are treated with antimicrobials before the development of clinical signs (prophylaxis). Because many management, husbandryand environment-based factors can impact on health and therefore antimicrobial usage on a farm, it may be difficult to identify and quantify the effect of individual factors that are consistently and strongly correlated with resistance and/or usage. This leads to the implementation of a multifactorial approach taking into account all noninfectious factors that are involved in the total health status of the herd.

These observations have led to the promotion of so-called “**good farming practice**” specifically **biosecurity** and **general hygiene** measures. Efforts to increase biosecurity have been implemented for a range of diseases, particularly for exotic epidemic diseases and steadily increasing for endemic diseases. Biosecurity refers to all aspects of the prevention of pathogens entering and spreading within a herd. It has been identified as a factor that negatively correlates with resistance of bacteria on pig farms. However, biosecurity is a complex concept which includes many components and is therefore difficult to measure. Also, farmer perception of biosecurity has been shown to be affected by a lack of

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incentives and by underestimation of risk. Recently, an online tool has been developed to support classification of farms in terms of biosecurity[4] and to help identifying critical points. While the development of such end-user tools are welcome, there is a need to evaluate and quantify the effects of corrective measures on herd health status and on antimicrobial consumption.

Among environmental factors influencing animal health in production systems where pigs are reared inside, building design and housing conditions need to be considered properly. There is an increasing amount of scientific evidences on the role of ventilation systems and the inside climatic conditions on diseases occurrence and severity, especially on lung diseases - one of the most common production diseases affecting growing pigs. Suitable buildings include equipment that is easy to handle; allow compartmentalization to avoid cross-contamination; allow the maintenance of healthy indoor climatic parameters; facilitate routine cleaning operations and are sized to reduce the spread of pathogens. Building manufacturers are key players in providing such buildings. This highlights the crucial need for a transversal approach involving all stakeholders (from farmers and veterinarians to agri-advisors and designers of pig farming equipments including buildings) to enhance animal health and welfare. Modifications of the building and housing conditions generally imply mid to long term investments for farmers. They are therefore slowly implemented. However, innovations in terms of building design and internal equipments - integrating scientific knowledge on the environmental key factors that alter health and welfare are still needed to implement more sustainable ways of rearing pigs.

Another area of suggested unspecific intervention is water and feed. Particularly after weaning, there is a high risk of diarrhoea due to change in the piglets' diet, and a substantial proportion of antimicrobial usage is due to this indication. **Feed composition** impacts on the digestive tract, particularly digestible crude protein. So-called "protective diets" are recommended for certain age groups, particularly around weaning. However, the impact of fermentable protein and protein-carbohydrate ratio on the intestinal microbiome needs to be further explored. Additionally the source of protein appears to be influential, i.e. plant *versus* animal source protein. Although the impact of protein sources on growth has been studied extensively, knowledge of their effect on the microbiome is still sparse. Molecular techniques now offer new opportunities to investigate this area further.

There are also some **feed additives** that are used to reduce the risk of gastro-intestinal infection in weaned pigs. Zinc was demonstrated to be beneficial during diet transition. ZnO has been shown to reduce faecal shedding of bacteria such as *Campylobacter coli* in pigs. Zinc is, however, not approved as a feed additive for pigs in all Member States and there are concerns regarding environmental contamination. Similar issues relate to the use of other metals such as copper. **Probiotics** are live microbial feed supplements. Most commonly used are bacillus, yeast and lactic-acid producing bacteria. Probiotics yield variable and often inconsistent effects. Their mechanisms of action are diverse and not completely understood. Alternatively, **prebiotics** can be used, *i.e.* feed containing ingredients increasing gut health. Polysaccharides and dietary fibres fall into this category. Their effect is thought to be mostly linked to selective growth of bacteria associated with a healthy gut. Combination of prebiotics and probiotics may also been used to prevent digestive disorders (called "symbiotics"). A new concept, "parabiotics", has recently been introduced and this refers to the use of inactivated microbial cells or

[4] http://www.biocheck.ugent.be/v4/home/

cell fractions to confer a health benefit to the host. Organic acids such as formic, lactic or benzoic acid can also have a beneficial effect around weaning when natural production of HCl is not yet adjusted to solid diets. Organic acids have been shown to reduce the occurrence of *Salmonella* and *E. coli*. Phytogenic feed additives have also been demonstrated to have a positive effect on production performance of pigs thus offering an alternative to antimicrobials. However, there is generally limited quality control for such feed additives as this is currently not compulsory. Furthermore, the impact and efficiency of the “biotics” products and phytogenic feed additives on the health of pig are not yet well established and require further investigations.

In the context of antimicrobial usage, **beliefs and attitudes** of farmers and veterinarians may be important factors determining prescription and usage patterns. A few studies examined pig farmers' psychosocial, demographic and farm characteristics regarding their use of antimicrobials. When comparing farmers and veterinarians, results indicated different knowledge levels, beliefs, attitudes, perceived risks. However, a comprehensive understanding of the psychosocial, external and demographical determinants of antimicrobial use or of alternative measures among pig farmers is lacking. Attitude towards antimicrobial use may also be influenced by information and education. Educational programmes may raise awareness and promote good practice in livestock production and veterinary prescriptions.

More generally, knowledge of the human factors regarding the resistance to change for best husbandry and management practices and higher levels of biosecurity, and the motivation and willingness to follow advised unspecific measures would assist in finding ways to adequately disseminate of such measures and leading to their full and effective implementation.

d) Measures aiming at specific disease prevention

Vaccination specifically increases an animal’s resistance against a specific pathogen. Unfortunately, the complexity of pathogen biology and pathogenesis yet prevents success for many diseases. Nevertheless, there are some highly effective vaccines available against several relevant pathogens in pigs. As vaccination comes at a cost, economic evaluation of their application on a farm-by-farm basis is important in decision making. It is expected that vaccination would also reduce the need for antimicrobial treatments. In pigs, it has been shown that vaccination against certain pathogens[5] reduced the need for treatment. However, the efficacy of vaccination as an alternative to antimicrobials has not been systematically investigated. Study designs vary between experiments, and results are often not integrated to provide sufficiently robust evidence across production systems. Effectiveness under field conditions may depend on many factors such as vaccination scheme, general health status of the animals and management factors. The effectiveness of vaccination and its economic benefit therefore need to be more comprehensively assessed.

In this context, **resistance of pigs** against specific agents could be increased through targeted breeding programmes if the genes responsible for disease susceptibility can be identified and eliminated and provided that there are no negative side-effects. In the past, such projects based on phenotypic selec-

[5] *Mycoplasma hyopneumoniae* and *Lawsonia intracellularis,* porcine circovirus type 2(PCV2)

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tion have yielded disappointing results. Yet, research looking into host resistance still suggests that such an approach might be effective, at least for some pathogens, for example porcine reproductive and respiratory syndrome (PRRS) virus. The traditional breeding approach is increasingly complemented and replaced by genomic approaches. Projects aiming at full genome sequencing are progressing and, in future, experimental insertion or deletion of genes may offer new, more rapid possibilities to manipulate and reduce the susceptibility of animals against specific agents. Genotyping may be used systematically for genomic selection and identification of phenotypic markers. The interaction of innate and adaptive immunity is a further research field that will inform future disease control strategies based on pig immunity.

3-1.4. Consequence assessments

The benefits of the use of antimicrobials are clear – livestock that are sick can be cured and become productive again. On the negative side, regular use of antimicrobials is likely to lead to the emergence of resistance, which limits the utility of antimicrobials in both animals and humans. There is a trade-off on the use of antimicrobials in livestock. The growing world population increases the demand for animal-derived food and increased livestock productivity. The latter was achieved through changes in the genetics of the livestock bred to efficiently utilise feeds, grow quickly, produce high individual quantities of milk or eggs and be able to be kept in confined and densely populated conditions. Such conditions increase the chance of transmission of diseases between animals and humans and change the profile of animal health problems, and the most common is a change in the need to manage intestinal and pulmonary infections in the case of meat animals and udder infections in the case of milk producing animals. Often this is achieved through the use of antimicrobials. The impact of changing production systems on the extent of antimicrobial usage across production systems is not well studied. The data available on antimicrobial use across countries seems to indicate that it may be possible to reduce antimicrobial use and retain highly intensive and productive systems of production. In order to pursue this approach, information is required on the impact of changes in production on disease occurrence and consequential usage of antimicrobials.

There is a risk of spread of resistant bacteria through the food chain, but significant research gaps remain for different livestock species and production system. An EU FP7 project called “EFFORT” is focusing on this topic and results will become available over the coming five years. A number of studies indicate already an association between antimicrobial use in livestock and resistance in bacteria, yet not a lot of them have quantified how this impacts on public health. There is a lack of data and information which can lead to uninformed policy making at international and national levels, poor development of private standards and ignorant choice of production systems at farm-level. Even less information is available on the significant quantity of antimicrobials used in food animals that might be excreted in urine and faeces under certain field conditions and might then be spread in the environment.

Glossary

Antibiotic	Generally used in the past to mean antimicrobials. However, it is now more often used to mean antibacterials and is understood by the public and professionals in this way. Almost exclusively now, when people talk about antibiotic resistance, they are talking about antibacterial resistance (HMA, 2012)
Antimicrobials	General term for natural or synthetic compounds which at certain concentrations inhibit growth of, or kill, micro-organisms. The term antimicrobials is a collective for anti-virals, anti-bacterials, anti-fungals and anti-protozoals (HMA, 2012)
Antimicrobial resistance	Antimicrobial resistance (AMR) is resistance of a microorganism to an antimicrobial medicine to which it was originally sensitive. Resistant organisms (they include bacteria, fungi, viruses and some parasites) are able to withstand attack by antimicrobial medicines, such as antibiotics, antifungals, antivirals, and antimalarials, so that standard treatments become ineffective and infections persist increasing risk of spread to others (WHO, 2013).
Co-resistance	Bacterial resistance to different antimicrobial agents caused by different resistance mechanisms (multi-drug resistance), Different genetic codes for resistance against the different agents are usually located on the same transferable genetic element, e.g. on plasmids or on transposons (EMA, 2003).
Cross-resistance	Bacterial resistance to different antimicrobial agents/substances which are usually from the same general class of antibiotics. The resistance mechanism against the different agents is identical (EMA, 2003).
Prophylaxis	Antimicrobials are administered to a herd or flock of animals at risk of disease but not yet displaying clinical signs.
Metaphylaxis	Antimicrobials are administered to clinically healthy animals belonging to the same flock or pen as animals that are already displaying clinical signs.
Microbiome	The totality of microorganisms and their collective genetic material present in or on the human body or in another environment (Lederberg and Mc Cray, 2001).
Multi-resistance	The term "**multi-resistance**" is used when a bacterial strain is resistant to several different antimicrobials or antimicrobial classes (EC 2011b).

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References

European Commission (EC), 2011a. Commission to the European Parliament and the Council. Action plan against the rising threats from antimicrobial Resistance. COM (2011) 748. http://ec.europa.eu/dgs/health_consumer/docs/communication_amr_2011_748_en.pdf

European Commission (EC). Antimicrobial road map.
http://ec.europa.eu/dgs/health_consumer/docs/road-map-amr_en.pdf

European Commission (EC), 2011b.
http://ec.europa.eu/health/opinions/triclosan/en/glossary/abc/bacterial-resistance.htm

European Food Safety Authority, 2008. Scientific opinion of the panel on biological hazards on a request from the European Food Safety Authority on foodborne antimicrobial resistance as a biological hazard. The EFSA Journal, 765, 1-87.

European Medicines Agency (EMA), European Surveillance of Veterinary Antimicrobial Consumption (ESVAC), 2013. Sales of veterinary antimicrobial agents in 25 EU/EEA countries in 2011, Third report (EMA/236501/2013).

European Medicines Agency, EMEA, 2003. Guideline on pre-authorisation studies to assess the potential for resistance resulting from the use of antimicrobial veterinary medicinal products (EMEA/CVMP/244/01-Final-corr)

Grave K, Torren-Edo J, Mackay D. 2010. Comparison of the sales of veterinary antibacterial agents between 10 European countries. *J Antimicrob Chemother*apy, 65(9):2037-2040.

Heads of Medicine Agencies (HMA), 2012.
http://www.hma.eu/fileadmin/dateien/Veterinary_medicines/00-HMA_Vet/02-HMA_Task_Force/03_HMA_vet_TF_AMR/2012_11_HMA_agreed_AB_AM_definitions.pdf

Lederberg and McCray, 2001. 'Ome sweet 'omics–A genealogical treasury of words. Scientist, 17: 8.

World Health Organization (WHO), 2013. http://www.who.int/mediacentre/factsheets/fs194/en/

3.2. Outcomes of the discussions of the focus group

During the first meeting, the group identified three main areas where practical solutions already exist or may be further developed to reduce the antimicrobials consumption, i.e. three main areas of further work for the focus group:

1. **General enhancement of animal health and welfare** without antibiotic use through better management and husbandry (stables layout, housing, biosecurity, euthanasia, early diagnostic detection) and training of personnel, veterinarians and advisors.
2. **Specific alternatives** to antibiotics including vaccination and breeding (measures to improve immunity and general constitution, feed additives/supplements, immunomodulators, new vaccines and ways of application). This topic aims to answer the question: How can animal health be improved specifically and unspecifically?
3. **Changing** attitudes, habits and human behaviour (farmers, agri-advisors and veterinarians) and **improving** information-dissemination. The underlying questions of this area are: how to change habits and attitudes towards antimicrobial usage, how to encourage a change in practice and transfer the scientific knowledge to farmers, advisors and veterinarians?

The participants started to identify the innovations and knowledge that are needed and the dissemination gaps. They also considered research questions, needs for data collection as well as the possible use of operational groups for field testing.

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4 - In-between meeting focus group work

After the first meeting, each focus group member was given the task of delivering at least one "mini paper" in which he/she analysed the assigned issue and list existing solutions and possibilities to tackle the problem or parts of the problem. The 16 mini papers are presented in Appendix. Theyare split in the three main areas as defined by the group during the first meeting and described above. The area of "general enhancement of animal health and welfare" was the most developed one with eleven mini-papers dealing with. Six mini-papers tackled the area related to attitudes, habits and human behavior changes and five developed solutions and possibilities related to specific alternatives. One may notes that four mini papers covered two or more areas.
A summary of these mini papers can be found in table 1, 2 and 3 related to the three main areas considered as strategic by the focus group to reduce antibiotics usage in pig herd. The tables are structured according to the four main objectives that should be addressed by the group during the second meeting (see below – from p. 17 to 22).

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The most frequently cited leverages to reduce antimicrobial usage are related to a better health and welfare of pigs and to social sciences, i.e. biosecurity, management practices of the sow and piglets, early detection systems and precision livestock farming, human attitudes, habits and behaviour determinants.

As regard to specific alternatives to antibiotics, the experts indicate that vaccination strategies need to be promoted and further vaccines should be developed. They also highlight the need for listing and assessing the effects of “biotics” feed additives (prebiotics, probiotics …). The experts strengthen the need to study the effects of such additives on production parameters, health and antimicrobial usage.

A horizontal thematic has also been identified as a key point to promote good existing practices, as a mean to encourage a change in human behaviour and to implement alternative treatments to antibiotics: the economy. Whatever the area, the experts stress the need for further assessment the existing strategies and innovative solutions to reduce antimicrobial usage using economical parameters to evaluate whether they are also beneficial from an economic point of view.

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5 - The second meeting

The second meeting shall be considered as the moment where the focus group is delivering an “draft” final product which may be further completed afterwards. It is therefore the place and moment for the elaboration and sharing of the practical proposals, focusing on all need details, giving guidance on how to transfer them among EU-pig farms.

5.1. Focus group expected outcomes

As monitoring of usage and antimicrobial resistance are specifically tackled in dedicated groups and European institutions, the present focus group should now concentrate on unspecific and specific measures to prevent diseases.

The focus group is intended to address four main areas to ultimately provide practical and innovative solutions to reduce antimicrobial usage in the pig industry:

1. To list good existing and partly develop husbandry, management and biosecurity practices and identify those practices that should be promoted and disseminated further
2. To identify the research results that need field testing and implementation
3. To provide a list of existing operational groups and ideas for new ones
4. To establish the needs for practical innovation, research innovation and research.

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5.2. Focus group work

During the second meeting, the experts are requested to help in further developing of the proposals drafted in the first phase while keeping in mind the four expected outcomes. The aim is to elaborate a set of proposals for good existing practices, for innovative solutions and to assess their effectiveness under variable EU conditions. The group should also identify needs from practice and propose directions for further research using a bottom-up approach. The second meeting is intended to propose priorities for innovative actions to test solutions and opportunities (e.g. ideas for future operational group projects) and disseminate the practical knowledge gathered.

In order to deliver on these objectives, the tables summarizing the mini papers may serve as a starting point for further discussion and all members of the focus group are requested to contribute in the following way:

- ✓ **Before the meeting**: check if the tables summarizing the mini papers are correct and complete. These tables should be considered as a working document submitted to further discussions and improvements, so that every members agree on it. They will be the media for the working groups during the first part of the second meeting. Please try to think about ideas to fulfill missing or partly developed areas, especially on proposals for future operational group projects, risk and downsides of the proposals, and how to promote them in various EU conditions.
- ✓ **Before and during the meeting**: further elaborate the list of proposals/solutions drafted in the three tables and contribute to write a draft product.

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Table 1

General enhancement of animal health and welfare

Table 1: General enhancement of animal health and welfare

I - Good existing practices underused or needing promotion				
Subtopic	**Why not implemented?**	**How to promote them further?**	**Main advantages?**	**Risk/downsides?**
Biosecurity				
External biosecurity measures	Lack of information / economic benefit and / effect on the reduction of antibiotics use Communication often focuses on the major economic impact of economic exotic diseases not on endemic diseases Difficult access of farmers to current scientific research outputs A breakdown during the pay-back period for the investment may be unacceptably high in densely populated areas Sustaining high standards of biosecurity on farms is not easy and is only likely to happen where it is developed as an ingrained part of the business culture	➢ To have **more evidence** that herds with **better biosecurity** have **more efficient production** ➢ Needs for **Europe-wide guidance** ➢ By focusing on **small and easy to achieve measures** that can be implemented without high workload or expensive infrastructural changes. ➢ **Providing more information and demonstration** when combining traditional production of guidelines for good biosecurity (manual) and using **modern communication tools** such as short video demonstrations, interactive web-based tools or games,... ➢ **Coaching individual herds** towards improved biosecurity and health management and reduced antimicrobial consumption.	➢ Reduction of the probability of infectious pathogens introduction	
Internal biosecurity measures	Variation in the effectiveness and impact of different biosecurity measures for individual diseases Cleaning and disinfection is considered a low category task due to the lack of improvement in cleaning techniques, lack of new products and the lack of control measures in order to be sure the job is correctly done Not considered by the stakeholders as a holistic approach (to improve the total health status) The needs or benefits are not always well understood. Obstacles to implement measures are not well identified. The measures that need to be improved is herd specific, not a single solution being effective for every herd		➢ Reduce exposure to infectious pathogens and decrease pathogen load within the herd ➢ Prevention of pathogens spreading between different groups of animals and within a group ➢ Coaching teams should gather on a regular basis, discussing the current situation based on objective parameters as well as possible changes for the next 6 months. Based on this they should come up with clear goals.	
Hygiene of drinking water (water quality from the source to the end of pipelines)	Farmers are not convinced that the control / improvement of the drinking water quality, has benefits for the animals, the production or the consumer	➢ **Collaboration of experts from different fields** is necessary (engineers, hygiene experts, veterinarians, drug designers and the farmers)	➢ Healthier animals lead to less antibiotic treatments. This, avoids the development of unwanted infectious agents and resistant bacteria and guarantees an effective treatment in cases where antibiotics are still needed	
Management and husbandry practices				
Weaning age: (3 or 4 extra days with the sow (not early weaning))				
Gilt selection, rearing and acclimatization		➢ Provide strict guidelines for gilt quarantine and adaptation period in the sow herd and for farrowing and newborn-piglet-management	➢ Improvement of gilts´ condition and health status of the breeding herd	
Newborn and suckling piglets management and environmental conditions (hot conditions, colostrum and milk supply)		➢ By providing husbandry advisory tools for risk assessment in order to quantify the impact of stress factors	➢ Avoiding hypothermia and hypoglycaemia in piglets and guarantee passively acquired immunity against commensal, environmental and pathogenic microorganisms ➢ Reducing stressful conditions ➢ Providing a more complex environment, better feed intake before and after weaning) and better growth	
All-in-all-out management in the farrowing unit			➢ Reducing stressful conditions which increase pig susceptibility to infectious diseases	
Keeping litters together, no mixing of social groups at a later age (including transport and at slaughter)				➢ Building size: the pen is not designed for the entire period of life of the pigs
More positive handling				
Feeding strategy (transitions, limited feeding at critical steps, secured feed composition)			➢ Reducing gut disturbances and promoting a positive microbiota	

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Table 1: General enhancement of animal health and welfare (continued)

I - Good existing practices underused or needing promotion				
Subtopic	**Why not implemented?**	**How to promote them further?**	**Main advantages?**	**Risk/downsides?**
Eradication of specific pathogens on farms				
Depopulation and repopulation	Cost and risk of reinfection with infectious pathogens involved in endemic diseases in densely populated areas when the efforts are carried out at the herd level	**Develop** a simple guide to carry out these programmes	➢ Restocking with high-health herds, free of many of endemic diseases.	➢ Cost, need high biosecurity measures and the risk of failure? with endemic diseases, especially in pig dense regions
Partial depopulation				➢ Use of heavy medication in the first steps of some programmes ➢ Not applicable for all infectious pathogens (difficult for S. suis) ➢ Not suitable in all kind of production systems (multi-sites with different suppliers)
Facilities design - housing				
Internal engineering	Lack of appropriate equipment meeting the requirements of the pigs: Providing the animals more than one temperature area for a better thermoregulation			
Manure storage: avoid under pigs	Changes in facilities may have dramatic effects on production but are implemented very slowly due to their huge costs			
Herd health management				
Health indicators: sow longevity, number piglets/sow/year…				
Responsible use of antimicrobials				
Dosing system for application of antimicrobials by water or feed		Facilitation of systems to treat sub-populations and individuals	➢ Avoiding overdosage and underdose (subtherapeutic doses of antimicrobials can be associated with an increased bacterial transfer of virulence genes between bacterial species)	

II - Research results needing to be implemented and partly developed promising concepts				
Subtopic	**Why not implemented?**	**How to promote them further?**	**Main advantages?**	**Risk/downsides?**
Biosecurity				
Risk-based assessment methods		➢ To develop applications for tablet computers and smartphones ➢ **To relate it to antimicrobial consumption**	➢ Allows identification of **critical control points** in the rearing process ➢ Taking corrective measures and **monitoring the impact of the changes** on animal health and welfare and on antimicrobial consumption	
Index of animal health and welfare				
Coaching concept on biosecurity			➢ Constant assessment from a multidisciplinary team	
Management and husbandry practices				
Risk-based assessment methods (tail biting)				
Reducing the number of husbandry procedures				
Increasing feed intake before and after weaning				
Facilities design - housing				
Cage free and group lactation, long lactation and insemination during lactation				
Early detection, precision livestock farming				
Herd health and building monitoring system (early detection)	On going technologies		➢ To react rapidly when a disease occurs ➢ To help farmers to monitor the health status of the pigs and to diagnose clinical signs of diseases at an early stage	➢ Implementation of this technology may be too expensive for old fashion farms ➢ Must not lead to, or be considered as a more “animal machine” way of rearing

Table 1: General enhancement of animal health and welfare (continued)

III - Operational groups
Existing groups
➢ Moonpigs (Dk)
➢ Bigcity (Nl)
➢ EU-PLF(ALL-SMART-PIGS)
Ideas for new ones

IV - Needs for innovation (practical &/or research)		
Areas needing exploration to find new practical solutions	**Important knowledge gap?**	**What research or technical innovation needed to work towards a practical solution?**
Biosecurity		
External and internal measures	Disease prevention and its role in reducing antimicrobial usage	
Hygiene of drinking water	On the risks and the disadvantages from a low quality drinking water in practice on animal health	➢ Hygienic indicators such as specific bacteria and important chemical factors should be defined ➢ The stability of drugs, especially of new designed drugs, in practice.
Economy	Economic evaluation of the relationship between biosecurity and herd health and antimicrobial consumption to evaluate whether the advised improvements are also beneficial from an economical point of view	➢ On biosecurity efficacy and its benefits from practical farm-based research studies
Coaching concept		➢ Assessment of how this coaching concept could be generalized towards many more herds in a country and many more countries to increase the impact.
Tools for end-users: risk assessment tools, real time decision making tools, simulation studies through modeling approach		➢ Improvement and adaptation of the scoring system on biosecurity: ➢ To quantify the effect of housing conditions on pig health and welfare under various EU climates in order to accurately weight these parameters. ➢ To build more complicated models including several infectious agents and to represent a disease with its consequences on animal welfare and performances in various production systems. ➢ Studies on the impact of biosecurity measures, management and husbandry practices and housing conditions on production and economical parameters
Cleaning and disinfection	Lack of knowledge about transmission of diseases (and resistance) coming from infected manure	➢ On easy clean and disinfection building and building equipment to improve the task performance (example: Auto-clean rooms) ➢ Technologies to facilitate cleaning and disinfection procedures (automatisation of the task, robot…)
Management and husbandry practices		
Suckling pigs management	➢ Critical points in early life that influence health (hence antibiotic use) and production in later life ➢ Relationship between the possibility to perform natural behaviour and the resilience, welfare and disease occurrence	➢ Designing new husbandry systems that enhance welfare and limit health threats (adequate piglet nestings …)
Breeding herd management		➢ Risk factors for diseases in breeding herd ➢ Identification of best practices for breeding herd management
Economy	Economic impacts of disease and the economic benefit of improved management (consequent performance of specific management measures).	
Facilities design - housing		
		➢ Assessment of the effect of new facilities not only on feed conversion but also on health and welfare parameters or environmental indicators ➢ These innovations will need to be adapted to the different countries in order to maximize their benefits

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Table 2

Specific alternatives to antibiotics

Table 2: Specific alternatives to antibiotics

I - Good existing practices underused or needing promotion				
Subtopic	**Why not implemented?**	**How to promote them further?**	**Main advantages?**	**Risk/downsides?**
Feed additives and supplements				
Heavy metals (ZnO)				➢ Environmental issues, possible link to antimicrobial resistance
Immunomodulators (cytokines, interferons, chemokines)				
Breeding for disease resistance or general robustness				
Vaccination				
Routine vaccination of sows	Vaccination effective against a specific disease, needs a lot of vaccine in some herds		➢ Increase protective maternally derived antibodies in piglets or support development of active immune reactions in piglets without an interference with maternal antibodies	
Vaccination of piglets and growing pigs according to the health status	Cost : choice of right vaccine based on continuous diagnostic measurements		➢ To prevent clinical signs of diseases or infectious pathogen transmission	➢ Too much immuno-modulation may create favorable conditions for the emergence of new diseases (example PMWS)
II - Research results needing to be implemented and partly developed promising concepts				
Feed additives				
Prebiotics, probiotics, symbiotics and parabiotics	The effects of the different products available on the pigs' health is incomplete		➢ Managing the gut microbiota to reduce digestive disorders occurrence and to enhance global health of the pigs	
II - Operational groups				
Existing groups				
Microbiota				
Ideas for new ones				

III - Needs for innovation (practical &/or research)		
Areas needing exploration to find new practical solutions	**Important knowledge gap?**	**What research or technical innovation needed to work towards a practical solution?**
Facilities design - housing		
Prebiotics, probiotics, symbiotics and parabiotics	➢ Efficacy of additives as prebiotics, probiotics is not well established or linked to a reduction of use of? antimicrobials	➢ Increase the research on the efficiency of these products supported by the knowledge on their action mechanism ➢ Genomic-based knowledge on the composition and functions of the gut microbiota as well as its disturbances allows the selection of more specific products and to study their activity in depth ➢ Meta-analysis of the effects of phytobiotics and prebiotics, probiotics, symbiotics and parabiotics
Disease resistance or general robustness		
Pig immune system	➢ Strategies to avoid the immunological gap after weaning	
Economy	➢ Economic benefit of gut health stabilizing measures such as the feeding of pro- and prebiotics or an environmental inoculation with specific bacteria	
Vaccination		
Efficacy	➢ The effects of vaccines (autogenous and new products) on antibiotic consumption	
Economy		➢ Economic evaluation when switching from antibiotics consumption to vaccination

Table 3

Attitudes, information and human behavior

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Table 3: Attitudes, information and human behavior

I - Good existing practices underused or needing promotion				
Subtopic	**Why not implemented?**	**How to promote them further?**	**Main advantages?**	**Risk/downsides?**
Means to encourage a change in practice				
Information and education	Lack of structured and supervised way to promote best practices/ good examples	➢ Using different channels and formats: by video, manual of best management practices, on line guidelines in different languages	➢ Education can assist further in creating an understanding of the need for change	
	Not enough co-ordinating body consisting of relevant stakeholders	➢ Vets need to improve their influencing skills to guide their clients towards change and training. Support for veterinarians in this role could be beneficial.	➢ Educational programmes can help raise awareness and promote good practice	
Attitudes towards antimicrobial usage among veterinarians and farmers				
Knowledge transfer to farmers, veterinarians and advisors				

II - Research results needing to be implemented and partly developed promising concepts				
Subtopic	**Why not implemented?**	**How to promote them further?**	**Main advantages?**	**Risk/downsides?**
Means to encourage a change in practice				
Benchmarking systems		➢ Risk communication of signal and action levels and best practice results of management etc. can be given to farmers by their vets or through the internet	➢ Implementation of such approaches was followed by a drop in antimicrobial consumption in some countries ➢ Allows comparison between herds to monitor the health status, the antimicrobial consumption while using standardized indicators at the national and European levels. ➢ This transfer of knowledge to farmers, vets and advisors will raise awareness of farmers and vets on their contribution to the antibiotic problem and how they can contribute to solve the problem. This ought to motivate them towards a reduced use ➢ Helps to create a vision and roadmap, in that producers and veterinarians can compare themselves with the average for the whole country and also see changes in usage/prescription habits over time	➢ Attention must be paid to risk communication (involving all stakeholders from farmer to veterinarians and farm advisors) through stakeholders association meetings, courses etc… ➢ Computer access for internet to the farmer and veterinarian
Vetstat				
Reward and sanction systems				➢ Poorer care of sick animals which could ultimately result in poorer animal welfare
Set political goals for antimicrobial reduction and rules (decoupling prescription and delivery)	Inconsistent results (decoupling approach resulted in a drop of antimicrobials consumption in Dk, but not in Spain and Italy)		➢ Will raise awareness between farmers to other farmers and among vets on own usage and thereby their contribution to the problem/solution	➢ Vets might be worried about not earning the same amount of money by 'just' advising in health and management.
Joint European Surveillance framework			➢ Producers and veterinarians can compare themselves to an EU standard and by doing so understanding where they are on the 'roadmap'.	
Creating a 'Burning Platform'			➢ Enhance the understanding towards the necessity for change. In business this is often done by explaining why change must happen and by creating a sense of urgency	
Clear road map			➢ Knowing why change is necessary is to have an understanding of what we are trying to change into and how we will do so	
Information - Communication				
Specific events: European Antibiotic Awareness Day and the range of activities and resources which follows the event; targeting both medical and veterinary use as well as the general public. For example, in the UK the British Veterinary Association produced guidance notes and posters for veterinarians and owners. The University of Liverpool arranged a stakeholder meeting for the veterinary profession to mark the event				
Treatment formularies / Guidelines on prudent antimicrobial usage	Difficult to establish the specific effects of such guidelines		➢ Such guidelines may well lay in the collaboration between stakeholders with a diverging perspective, and if this is the case, such guidelines need to be an 'active' document - continuously evaluated and discussed.	

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Table 3: Attitudes, information and human behavior (continued)

II - Research results needing to be implemented and partly developed promising concepts				
Subtopic	**Why not implemented?**	**How to promote them further?**	**Main advantages?**	**Risk/downsides?**
Knowledge transfer and sharing experiences				
Erfa-groups			➢ Trustworthy forum for knowledge exchange ➢ Bringing together persons related to high/low consumption farms and organic farms may broaden the view on new/alternative solutions. ➢ To focus on low consuming herds in general and not only on organic herds as some resistance otherwise may occur. ➢ Suitable for transfer/dissemination of knowledge from research to herds	
Experience sharing (farmer self-help groups, Best Practice Manuals)	Not easy to implement in countries that have no tradition in openness and sharing experiences., A model is needed that suits countries where there is not such an 'open' culture			
Structured educational programmes and material				
Influencing skills of veterinarians				
On-farm advice (general and for high users)				
Use of good examples (low users, e.g. specific countries, organic producers)				

III - Operational groups
Existing groups
Farmer self-help groups (Dk)
Ideas for new ones

IV - Needs for innovation (practical &/or research)		
Areas needing exploration to find new practical solutions	**Important knowledge gap?**	**What research or technical innovation needed to work towards a practical solution?**
Means to encourage a change in practice		
Cost-benefit analysis for end user / consequence assessments	➢ Consequence Assessments/ Establishment of cost-benefit at farm level are necessary to drive change in behaviour	
Taxing/pricing strategies		➢ On the effects of pricing/taxation strategies
On farm target pathogen sensitivity testing - improved sensitivity testing and services (speed and cost)		
Prescribing-dispensing	➢ The pros and cons of decoupling veterinarians' ability to dispense antimicrobials	➢ To address concerns about de-coupling of prescribing and dispensing
Attitudes towards antimicrobial usage among veterinarians and farmers		
	➢ Interaction between social, economic and technical factors, all of them driven the decision making process ➢ Gap on factors motivating an action and how strong a motivator the action is. It would help to alter the motivation or find a substitute for a contra productive motivator	➢ To identify the trajectory of change in practice of farmers who are using less and less antibiotics ➢ To identify factors, habits or legislation/rules that enables/encourage some farmers and veterinarians to keep the AM consumption at a low level while others don't ➢ Comparing the characteristics (social behaviour, attitudes, beliefs..) of low (organic) and high consumption herds ➢ Intervention studies ➢ Factors influencing antibiotic prescription habits amongst veterinarians

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Appendix:

Mini papers

AREA 1

General enhancement of animal health and welfare

Biosecurity: making an intangible tangible

Derek Armstrong

Good biosecurity is seen as key to reduce the risk of disease agents being introduced and spread not just at farm level but also at regional and national boundaries. Considerable time and effort has been invested in promoting and encouraging farmers to improve biosecurity. Information on improving biosecurity practice (e.g. Pitkin et al., 2009; BPEX, 2006) is widely available but it is not always consistently and effectively implemented on farm.

Communication on the importance of biosecurity often focuses on the major economic impact of epidemic exotic diseases at national level. In the 1997-98 outbreak of Classical Swine Fever in the Netherlands 429 farms were infected and detected, more than 13,000 farms were involved in one or more control measures, and more than 11 million pigs were destroyed. The total financial consequences of the outbreak were estimated at US $2.3 billion (Meuwissen et al., 1999). The cost of the 2001 outbreak of Foot and mouth disease to public and private sector has been estimated at over £8billion (National Audit Office, 2002).

In the US the productivity losses associated with Porcine Reproductive and Respiratory Syndrome virus has been estimated at US$664 million annually (Holtkamp et al. 2013). The economic impact of Post-weaning multi-systemic wasting syndrome (PMWS) for the English pig industry for the year 2008, prior to the introduction of Porcine Circovirus Type 2 (PCV2) vaccines, has been estimated at £52.6 million per year and at approximately £88 million per year during the epidemic period (Alarcon et al., 2013). These estimates of losses associated with disease can be difficult to relate to in the daily management of an individual farm business.

The study by Dr Maria Laanen and her colleagues at Ghent University, published in a recent issue of The Veterinary Journal, presents useful evidence on the potential value of both external and internal biosecurity at farm level (Laanen et al., 2013). **The current industry paradigm is that herds with better biosecurity should have more efficient production but more evidence in support of this is needed.** In the study **both external and internal biosecurity scores** of the farms were positively associated with average daily gain and negatively associated with feed conversion ratio in finishing pigs but only internal biosecurity scores were associated with a reduction in antimicrobial treatments.

Changing attitudes to biosecurity among pig farmers will be critical **to reducing both the risk of introducing disease and the impact of and treatment for disease.** In a study with Dutch pig farmers perceived benefits in terms of strategy efficacy was the strongest direct predictor of strategy adoption (Valeeva et al., 2011). **Attitudes of farmers in the UK towards specific measures and their efficacy were major factors that influenced livestock farmers' decision on whether or not to implement specific disease risk measures (Garforth et al., 2013).**

It is important, **therefore, that information on efficacy and benefits from practical farm-based research studies bridge the emerging gap between research and practice.** Lack of awareness and difficult access of producers to current scientific research outputs were highlighted by Alarcon et al., 2013, as key barriers to communication across the research-practice divide. There is a challenge to **avoid over-simplification in communication of research findings**. As acknowledged by Laanen et al., 2013, the variation in performance that is explained by differences in biosecurity may be related to other management factors. A willingness to adopt good biosecurity practices may be part of an approach to implementing higher standards of good management practices **and it may not be practical or valid to try to assign specific cost-benefits to individual measures in isolation.** There may **also be variation in the effectiveness and impact of different biosecurity measures for individual diseases** and in this study there did not appear to be an impact on Salmonella S/P scores.

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The **association between higher standards of biosecurity and younger farmers** identified by Laanen and her colleagues may represent more exposure to advice on biosecurity in their training resulting a greater readiness to build a culture of good biosecurity into their businesses. Unless there is a clear commitment to maintaining high levels of biosecurity investing in disease elimination, for example, may be a waste of time and money as **the probability of a breakdown during the pay-back period for the investment may be unacceptably high. Sustaining high standards of biosecurity on farms is not easy and is only likely to happen where it is developed as an ingrained part of the business culture.** In providing tangible evidence of the intangible benefits of good biosecurity Laanen and her colleagues have helped to build the case for developing a stronger culture of good biosecurity on pig farms.

References

Alarcon, P., Rushton, J., Wieland, B., 2013. Cost of post-weaning multi-systemic wasting syndrome and porcine circovirus type-2 subclinical infection in England - An economic disease model. Preventive Veterinary Medicine 110, 88-102.

Alarcon, P., Wieland, B., Mateus, A., Dewberry, C., 2013. Pig farmers' perceptions, attitudes, influences and management of information in the decision-making process for disease control. Preventive Veterinary Medicine http://dx.doi.org/10.1016/j.prevetmed.2013.08.004

BPEX, 2006. Bio Aware - Bio Secure: healthier pigs and a healthier business. http://smartstore.bpex.org.uk/articles/dodownload.asp?a=smartstore.bpex.org.uk.16.4.2008.9.41.45.pdf&i=295303. Accessed: 18/10/13.

Garforth, C., Bailey, A. Tranter, R., 2013.Farmers' attitudes to disease risk management in England: a comparative analysis of sheep and pig farmers. Preventive Veterinary Medicine 110, 456-466.

Holtkamp, D., Kliebenstein, J., Neumann, E., Zimmerman, J., Rotto, H., Yoder, T., Wang, C., Yeske, P., Mowrer, C., Haley, C., 2013. Assessment of the economic impact of porcine reproductive and respiratory syndrome virus on United States pork producers. Journal of Swine Health and Production 21, 72-84.

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. The Veterinary Journal http://dx.doi.org/10.1016/j.tvjl.2013.08.029

Meuwissen, M., Horst, S., Huirne, R., Dijkhuizen, A., 1999. A model to estimate the financial consequences of classical swine fever outbreaks: principles and outcomes. Preventive Veterinary Medicine 42, 249-270

National Audit Office, 2002. The 2001 Outbreak of Foot and Mouth Disease, Report by the Comptroller and Auditor-General, 21 June 2002. www.nao.org.uk/wp-content/uploads/2002/06/0102939.pdf. Accessed: 18/10/13.

Pitkin, A., Otake, S., Dee, S., 2009. Biosecurity protocols for the prevention of spread of PRRS virus http://www.aasv.org/aasv/PRRSV_BiosecurityManual.pdf. Accessed: 18/10/13.

Valeeva, N., van Asseldonk, M., Backus, G., 2011. Perceived risk and strategy efficacy as motivators of risk management strategy adoption to prevent animal diseases in pig farming. Preventive Veterinary Medicine 102, 284–295.

Mini-paper on improving herd health by eradicating endemic diseases

David Burch, Octagon Services Ltd, UK

Introduction

Much of the time farmers will live with one or more endemic infection in their pigs and try to control them with vaccination or the use of antibiotics. Enzootic pneumonia (*Mycoplasma hyopneumoniae*), swine dysentery (*Brachyspira hyodysenteriae*), Actinobacillus pleuropneumonia (*A. pleuropneumoniae*), Streptococcus meningitis/arthritis (*S. suis*) and porcine reproductive and respiratory syndrome virus (PRRSV) are typical examples. It is only when the weight of infection has increased and the profitability has suffered or when antibiotic resistance has become complete, especially in the case of swine dysentery, that they will consider complete **depopulation and repopulation**. This is an opportunity to restock with high-health herds, free of many of the above diseases. Repopulation with high-health stock does have its own issues, such as cost, herd biosecurity and the risk of breaking down with endemic diseases, especially in pig dense regions.

Partial depopulation, usually of young stock and a focus on immune sow herds, where the incidence of infection is already low, to either treat them to eliminate *M. hyopneumoniae*, *A. pleuropneumoniae, B. hyodysenteriae* or multi-vaccinate against PRRSV have all been described. The uptake of these initiatives is relatively low, even in weaner producing herds, as the growing and finishing herds they supply are often of mixed health-status, thus maintaining the status quo of low overall health and the need to routinely use vaccines and antibiotics.

Solutions and possibilities

1. There are **existing and tested solutions** for *M. hyopneumoniae* (Burch and Woolfenden, 2010) and susceptible *B. hyodysenteriae* (Burch and Howells, 2010). The merits (cost/benefit) of eliminating these diseases could be highlighted more strongly to farmers.

2. There are **promising concepts** for *A. pleuropneumoniae*, **also with the use of medication** but these could be further explored to increase the success rate. PRRSV has been eliminated on a farm basis and also on a regional basis (France) by the use of poly-vaccination of the breeding herd, closing up of the sow herd, and strict biosecurity improvements. A method for EU PRS strains has been reported but I have not seen one on either the US vaccine strains circulating or mixed EU/US infections. A simple guide to carry out these programmes could be developed and would be helpful.

3. The eradication of *S. suis* has proven very complex, with few descriptions of successful elimination and a **new solution** could prove most helpful. The disease itself is thought to have increased and become more significant since the introduction of PRRSV. PRRSV vaccine virus has been used to help induce infections in challenge models with *S. suis* in the US (Halbur et al, 2000). The interaction of the infection with poor housing, ventilation etc and other pathogens could be reviewed (possibly part of the Prohealth Project) but the establishment of a suitable eradication programme could prove most helpful and have a substantial effect on the reduction of penicillin and cephalosporin use in pigs.

References

Halbur, PG, Schmitt, C & Thanawongnuwech, R (2000) PRRSV and *S. suis* Type 2 coinfection of nursery pigs. Proceedings of the AASV Meeting, Indianapolis, Indiana, USA, pp 319-323.

Burch, DGS & Woolfenden, NJ (2010) Economic benefits from the eradication of enzootic pneumonia and PRRS from an 800-gilt herd. Proceedings of the IPVS Congress, Vancouver, Canada, vol 2, p 675.

Burch, DGS & Howells, MJ (2010) Eradication of swine dysentery in an outdoor breeding herd and its production pyramid. Proceedings of the IPVS Congress, Vancouver, Canada, vol 2, p 732.

DGSB 2/1/13

Mini-paper on disease prevention and reduction of antimicrobial consumption through improved biosecurity.

Jeroen Dewulf, Ghent University, Belgium

Introduction

Biosecurity embraces all aspects of the prevention of pathogens entering and spreading within a group of animals (Amass and Clark, 1999), and can thus be divided into two parts. External biosecurity relates to the prevention of pathogens entering a herd, and internal biosecurity is how the spread of pathogens within a herd is reduced. It is assumed that **higher levels of biosecurity lead to improved animal health and productivity, and to a reduction of the use of antimicrobials** (Ribbens et al., 2008), which are important features of sustainable animal production. In the past specific biosecurity or management measures have often been related to **the prevention of specific disease.** In these the external biosecurity measures were often promoted in the framework of the prevention of epidemic diseases such as classical swine fever or Aujeszky's disease, whereas specific internal biosecurity measures have been promoted in the framework of the control of endemic (e.g. enzootic pneumonia, Streptococci,…) or zoonotic diseases (eg. salmonella). Only recently interest has grown in the **holistic approach of biosecurity** as a tool to improve the total health status of the herd taking into account all potentially present clinical and subclinical diseases.

Since a number of years a **risk-based weighted biosecurity scoring system** (Biocheck.ugent) has now become available (Laanen et al., 2010). This methodology provides a handle to score biosecurity in pig herds in an objective and transparent manner and **to relate these scores, or the evolution in the scores, to the health status of the herd or the level of antimicrobial consumption**. Using this weighted risk-based biosecurity score accounts for the fact that on different herds, depending on the specific herd situation, different measures are to be taken and that also limited changes in management and hygiene procedures may have important impacts. **Very recently the first study results were published showing significant and favourable association between biosecurity scores and production factors and antimicrobial use in pig herds** (Laanen et al., 2013).

Solutions and possibilities

It is generally accepted that improved biosecurity results in better herd health which on its turn results in reduced antimicrobial use. Yet, it remains often difficult to convince farmers of the need, benefits and achievability of these improvements.

1. At the **demonstration level** there is need for European wide guidance and demonstrations of good biosecurity practices. In these it is important to focus on small and easy to achieve measures that can be implemented without high workload or expensive infrastructural changes. Examples are use of working lines, change of clothes and footwear between age groups, hand washing, improved cleaning and disinfection in between production rounds,….. This dissemination of information and demonstrations could be done by a combination of **traditional production of guidelines for good biosecurity but also using modern communication tools such as short video demonstrations, interactive web-based tools or games,…**

2. At the **motivation level** there is good experience in several countries (e.g. Belgium, The Netherlands,…) with **coaching individual herds towards improved biosecurity and health management and reduced antimicrobial consumption.** This coaching is based on a team effort with at least the farmer, the herd veterinarian and an external and neutral coach involved. Depending on the specific situation the groups can be expanded with additional influential herd advisors such as feed or climate experts. These teams should gather on a regular basis (eg twice a year) and discuss the current situation based on objective parameters (eg. biosecurity score, quantification of the antimicrobial use, disease diagnostics, ….) as well as possible changes for the next 6 months and

based on this come up with clear goals. There is a need to evaluate how this coaching concept could be generalized to much more herds in a country and much more countries to enlarge the impact.

3. At the **research level** there is need for **continuous improvement of the existing biosecurity scoring systems** (especially as the attribution of the weights (=risks) to the different aspects of biosecurity is concerned). Moreover the available scoring systems need to be adapted to other types of pig production not yet included, such as outdoor production. Finally there is urgent need for involvement of **economic evaluation of the relationship between biosecurity and herd health and antimicrobial consumption to evaluate whether the advised improvements are also beneficial from an economical point of view**.

References

Amass, S.F., Clark, L.K., 1999. Biosecurity considerations for pork production units. Swine Health and Production 7, 217–228.

Ribbens, S., Dewulf, J., Koenen, F., Mintiens, K., De Sadeleer, L., de Kruif, A., Maes, D., 2008. A survey on biosecurity and management practices in Belgian pig herds. Preventive Veterinary Medicine 83, 228–241.

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. Flemish Veterinary Journal 79, 302–306 (in Dutch).

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. The Veterinary Journal 198: 508-512.

Main topic: General enhancement of animal health and welfare

Christelle FABLET

Introduction

In modern swine rearing systems, numerous factors may impair the health and welfare of animals from an infectious component to noninfectious one, *i.e.* the environment in which animals are kept, both components being interrelated. Environmental noninfectious factors include herd management, husbandry practices, housing and biosecurity. In many cases, particularly for enzootic production diseases, the environment provided to the pigs influences the course and severity of disease expression (Madec et al., 1998; Fablet et al., 2009). Those noninfectious factors act on the pathogen load, *i.e.* the amount of microorganisms to which the pig is exposed, and on the pig, by modulating the defense mechanisms through which the pig handles the pathogen challenge (Gonyou et al., 2006). Disease outcome depends on the balance between the infection pressure and the pig's ability to resist them. In swine herds using intensive rearing system, multiple environmental factors may interfere with this delicate balance and need to be considered and adapted in order to reduce disease incidence and severity. While ventilation and climatic parameters are interrelated and influence pig susceptibility and consequently the establishment of the infection, hygienic factors mainly affect the infection pressure. Husbandry practices may interact directly with both the infection pressure and the pig susceptibility to diseases or indirectly by influencing hygienic factors. Herd characteristics can also impact indirectly the infection pressure through management. Hence, preventive non medicated measures could therefore been used to improve animal health and welfare: management, biosecurity and husbandry being part of the leverages to reduce the risk of production diseases occurrence and by the way the antimicrobial use.

Although there is an increasing amount of scientific evidences of the role of herd management, housing, husbandry and biosecurity in animal diseases, a wide level of progress still remains in these areas in most pig herds. It seems like the scientific knowledge is not transform into practical innovative actions by the stakeholders. This may be due to a lack of availability of this knowledge and a lack of interactions between all of the actors of the animal health sector.

Solutions and possibilities

1. To transform the scientific knowledge into practical innovative easy to handle tools for the stakeholders:

- There is a need to develop and promote EU tools to help stakeholders to better take into account the effect of noninfectious factors when tackling production diseases and health troubles. In this aim, **standardized risk-based analysis tools** as regard to **environmental noninfectious factors** which impaired animal health and welfare should be implemented at the herd and batch levels. Such kind of tools, based on the results of scientific research, would allow identifying **critical control points** in the rearing process. Then, corrective measures may be taken and the impact of the changes on animal health and welfare and on antimicrobial consumption may be assessed. As an example, a risk-based weighted biosecurity scoring system has recently been designed in Belgium and is now available on the web (Biocheck.ugent). It allows identifying measures which may be taken at the herd level to improve the health status and to relate it to the level of antimicrobial consumption. The biocheck scoring system focus on biosecurity. Since pig housing also influence the disease outcome and welfare, parameters related to the physical environment offered to the pigs, *i.e.* buildings and ventilation management, should be included in a broader risk-based weighted scoring system. More research is required to quantify the effect of housing conditions on pig health and welfare under various EU climates in order to accurately weight these parameters. Tablet computers and smartphones are now widely used by the stakeholders and allow the dissemination of such innovative tools.

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- **Precision livestock farming techniques** (PLF) provide promising results to help farmers in herd management and early detection of health troubles. PLF technology relies on the implementation of sensors, cameras and microphones in livestock housing to deliver a fully automated continuous monitoring and management system for the farmer. Research studies are going on in the EU under the seventh framework programme for research and innovation (FP7) (eu-plf.eu). For instance, automatic sound monitoring system is being designed to monitor cough sounds. It aims to help farmers to monitor the respiratory health status of the pigs and to early diagnose clinical signs of respiratory diseases (Ferrari et al., 2013). Implementation of smart farm concept is starting in EU-countries. In France, a consortium is being created to promote the development of PLF techniques in pig herds. A limitation of such smart-farming techniques may be related to their costs. Implementation of this technology may be too expensive for old fashion farms. When these solutions are applied some attention are needed as regard to their uses. They must be taken as real-time **decision-making tools**, which help producers to implement management changes and to early detect health and welfare disorders and they must not lead or be considered to a more "animal machine" way of rearing.
- **Modelling approaches** have been used in pig production as tools for decision makers to study the impact of reproductive performances (Allen and Stewart, 1983; Singh, 1986) or replacement policies (Jalvingh et al., 1992; Pla` et al., 2003) on economic parameters. Recently, mathematical models have also been developed to describe the within-herd infectious process towards major swine pathogens involved in production diseases (PCV-2 and PRRSV) or food-borne diseases (Lurette et al., 2007; Andraud et al., 2009; Evans et al., 2010). By co-representing the dynamics of the animal population and the contact structure within pig herds and the course of infection of infectious pathogens, modelling provides a suitable tool for identifying which **change** in management or control policy is **most likely to have a significant quantitative impact on the dynamics of an infectious pathogen in a pig herd** (Andraud et al., 2009). This is particularly the case when the model is based on individuals: it allows representing individual processes within the population including localization in space and time of all individuals and therefore allows a detailed representation of husbandry and management practices. Such tools are relevant for **prospective *in silico* studies** to assess the effect of management and husbandry practices changes on animal health in a given pig herd. It may help in the decision process when willing to implement modifications in an existing herd or when designing new pig herd. Until now, such models have been applied to study the infection dynamic of a single pathogen in farrow-to-finish systems. Research is needed to build more complicated model including several infectious agents and to represent a disease with its consequences on animal welfare and performances. They also need to be adapted to other types of pig production systems, such as multisite production or different pig herd sizes.

2. To motivate the farmers to change their practices

- **Economical parameters** are involved **in the decision process of the stakeholders.** The economic impacts of the advised improvements or putative strategies would therefore be addressed to guide stakeholders' decisions when willing to implement modifications. Indeed, this is a crucial point to convince them of the relevance of correcting noninfectious factors to enhance the general health and welfare of the herd without using antimicrobials. Studies on the impact of biosecurity measures, management and husbandry practices and housing conditions on production and economical parameters are required to include an economical part in all above mentioned decision-making tools.

References

Allen, M.A., Stewart, T.S., 1983. A simulation model for a swine breeding unit producing feeder pigs. Agric. Syst. 10, 193–211.

Andraud, M., Rose, N., Grasland, B., Pierre, J.S., Jestin, A., Madec, F. 2009. Influence of husbandry and control measures on porcine circovirus type 2 (PCV-2) dynamics within a farrow-to-finish pig farm: a modeling approach. Prev. Vet. Med. 92, 38-51.

Evans, C.M., Medley, G.F., Creasey, S.J., Green, L.E., 2010. A stochastic mathematical model of the within-herd transmission dynamics of porcine reproductive and respiratory syndrome virus (PRRSV): Fade-out and persistence. Prev. Vet. Med., 93, 248-257.

Fablet, C., 2009. An overview of the impact of the environment on enzootic respiratory diseases in pigs. In: Aland, A., Madec, F. (Eds.), Sustainable Animal Production. Wageningen Academic Publishers, Wageningen, The Netherlands, pp. 269–290.

Ferrari, S., Silva, M., Exadaktulos, V., Berckmans, D., Guarino, M. 2013. The sound makes the diffrenece : the utility of real time sound analyis for health monitoring in pigs. In: Aland, A., Banhazi, T. (Eds), Livestock housing: modern management to ensure optimal health and welfare of farm animals. Wageningen Academic Publishers, Wageningen, The Netherlands, pp. 407-417.

Gonyou, H.W., Lemay, S.P., Zhang, Y., 2006. Effects of the environment on productivity and disease. In: Straw, B., Zimmermann, W., D'Allaire, S., Taylor, D.J. (Eds.), Diseases of Swine. , 9th ed. Blackwell Publishing, Ames, Iowa, pp. 1027–1038.

Jalvingh, A.W., Dijkhuizen, A.A., Vab arendonk, J.A.M., Brascamp, E.W., 1992. An economic comparison of management strategies on reproduction and replacement in sow herds using a dynamic probabilistic model. Livest. Prod. 32, 331–350.

Lurette, A., Belloc, C., Touzeau, S., Hoch, T., Seegers, H., Fourichon, C., 2007. Modelling batch farrowing management within a farrow-to-finish pig herd: influence of management on contact structure and pig delivery to the slaughterhouse. Animal 2, 106–116.

Madec, F., Bridoux, N., Bounaix, S., Jestin, A., 1998. Measurement of digestive disorders in the piglet at weaning and related risk factors. Prev. Vet. Med. 35, 53-72.

Pla` , L.M., Pomar, C., Pomar, J., 2003. A markovian decision sow model representing the productive lifespan of herd sows. Agric. Syst. 76, 253–272.

Singh, D., 1986. Simulation of swine herd population dynamics. Agric.Syst. 22, 157–183.

Edgar Manzanilla

Introduction

Since the 1940's, animal production has evolved using antimicrobials as part of the daily practice. Thus, all other aspects of animal production are, to some extent, dependent on antimicrobial use. Some pig management practices as early weaning or mixing origins in high density fattening units may be really difficult in practice not having antimicrobials as backup. Thus, producing pigs without antibiotics or with a significantly lower amount will require important innovative strategies to improve the current production systems.

The success of innovations in the animal production systems depend normally on **how beneficial** and **how expensive** they are. Thus, feed additives as alternatives to antibiotics growth promoters are in many cases not very effective but they are in general quite cheap and so they are often included in feeds. On the other hand, changes in facilities may have dramatic effects on production but are implemented very slowly due to their huge costs.

Facility and management innovation

When talking about the topic "general enhancement of animal health and welfare", biosecurity measures are well known and they are very effective in disease prevention. Thus their use should be encouraged. However, research on new facilities and new management systems is underdeveloped despite its large potential for the improvement of animal health and welfare. It is also very slow due to its high implementation costs. The implementation of sows in groups in the EU may be a very good example of how slow it can be.

Antibiotic use in swine production has two very important uses; **digestive problems at weaning** and **digestive/respiratory problems at growth**. In both cases, changes in facility/management could be highly important in reducing its use but these changes would be also quite expensive.

<u>Digestive problems at weaning:</u> Tones of money have been invested in the development new feed additives for the early-weaning pig with very little success. In many cases a better solution has been allowing piglets to have 3 or 4 extra days with the sow. Very interesting systems, similar to those used in organic production, are already available but it will take long time before they make it to the real world if they are not pushed with data and constant improvement. Some innovations partially developed are cage free and group lactation, long lactation and insemination during lactation.

<u>Digestive/respiratory problems in fattening units:</u> Very few relevant changes have been introduced in this production phase for long time. Despite the improvement in ventilation and feeding systems the basic structure of the building remains highly poor in design. Providing the animals more than one temperature areas for a better thermoregulation or avoiding manure to be stored under the animals might be simple modifications with huge effects on pig health. These modifications are not very developed and are quite expensive to study.

In many cases, these innovations are evaluated in the current production system as a single modification and measuring their effects on how the animal transforms feed into meat. However, these innovations will rarely be efficient by themselves as single changes and will need further development. Including farmers/veterinarians or any other final users in the development process will help being successful and timely implemented. In many cases, not only feed conversion will be important in the evaluation of these innovations. For example, improving pig's thermoregulation ability may save power for heating even when the FCR may be increased. Finally, these innovations will need to be adapted to the different countries in order to maximize their benefits.

Healthy neonates as the basis for herd health

Isabel Hennig-Pauka

Introduction

The reduction of antibiotic usage in pig production will be the main task for farmers and swine practitioners in the future to meet the demands of the consumers and legislation. Most frequent indications for treatment are respiratory and gastrointestinal diseases, with beta-laktam-antibiotics and tetracyclins being applied most frequently. In most studies a high farm-to-farm variability as well as an on-farm variability between different periods in the frequency of therapy (antimicrobial doses per pig in one fattening period) are reported. This indicated that - in general - antibiotic treatment is initiated after diagnostic of herd health problems and not prophylactically. The definition of a metaphylactic use of antibiotics on herd level is a controversial issue, especially in those cases in which the farmer empirically knows that specific disease problems will arise in a specific age group if he is not administering antibiotics (e.g. *S. suis*).

The image of pork has declined over the last years. One criticism is, that antibiotics are used to stabilize herd health by a compensation of housing and management practices which cause disease (technopathies) or increase the susceptibility towards infectious diseases. BUT: From the medicinal and scientific point of view the cause-effect relationship is not always easy to proof in complex systems (interaction between microorganisms, macroorganisms, environment on farms). The challenges for swine practitioners are i) to find out the herd-specific constellation of factors responsible for development of disease, ii) to identify the most important factors which should be eliminated first to have the most sustainable impact onto herd health and iii) to present the economic benefit of elimination of these factors in order to convince the farmer and achieve a consequent and constant realization of instructed measures.

One basic concept to improve herd health is to strengthen the immune status of the herd. At first **innate immunity** of the herd should be stabilized. It has been shown for several pathogens, that the efficiency of innate immune reactions is decisive for the outcome of disease. Secondly, **adaptive immunity** should be improved by specific vaccination strategies as well as by adaptation periods of pig groups which allows the development of naturally acquired immunity.

Existing solutions which should be promoted

Several good and satisfactory farming practices should be further developed and adjusted to /implemented on farms. The economic benefit and the effect onto the reduction of antibiotics of those practices should be elaborated. These experiences must be shared with stakeholders.

1. Eradication of specific pathogens on farms as *Actinobacillus pleuropneumoniae*, *Sarcoptes suis*, *Ascaris suum*, toxigenic Pasteurella multocida, (PRRSV –depends on herd health status, environment and neighbourhood).
2. Routine vaccination of sows against parvovirus and erysipelas and of piglets against *M. hyopneumoniae* and PCV2.
3. Continuous assessment of herd health according to few parameters: sows longevity, weaned piglets per sow per year, piglets´ index, living piglets on the fifth living day per litter, slaughterhouse feedback of pathological organ alterations, mortality rates, frequency of therapy

(number of antimicrobials*number of animals* number of treatment days/ animals in one evaluation period)

4. Obligation to use fully developed dosing system for application of antimicrobials by water or feed to avoid overdosage and underdose, because subtherapeutic doses of antimicrobials can be associated with an increased bacterial transfer of virulence genes between bacterial species (Brewer et al. 2013).
5. Starting on farms with improvement of most sustainable aspects of external biosecurity (purchase of animals from one origin with known health status, quarantine) and internal bisosecurity (improvement of management especially in the farrowing and suckling period).
6. Stabilizing health of suckling piglets as the basis for herd health starting with gilt selection and rearing with emphasis onto teats and fundament, strict guidelines for gilt quarantine and adaptation period in the sow herd, as well as guidelines for farrowing and newborn-piglet-management.

Stabilizing the immune system in the early life

In epidemiological studies it was proven, that already in the period of farrowing and suckling the course for the herd health status is set. In the first hours birth weight, piglet vitality, sows´ condition and health status as well as availability of teats/milk are preconditions to avoid hypothermia and hypoglycaemia in piglets and guarantee passively acquired immunity against commensal, environmental and pathogenic microorganisms.

Protection against microorgansims

During protection by maternal antibodies piglets should start to develop active immunity against several pathogens. Scientific work should focus onto strategies to avoid the immunological gap after weaning, when maternal antibody level declined and development of active immunity is not finished.

Especially for facultative pathogenic microorganisms (e.g. *S. suis, H. parasuis*) but also for major pathogens as *M. hyopneumoniae*, vaccination strategies should be elaborated, which either increase protective maternally derived antibodies in piglets or support development of active immune reactions in piglets without an interference with maternal antibodies.

Impact of stressors

The impact of stress reactions (e.g. cortisol, catecholamines) onto the immune system has been shown in several studies. In addition, a direct effect of catecholamins onto virulence factor expression of pathogenic bacteria was found (Li et al. 2012). Major stressors in newborn are cold and lack of milk, later weaning, group mixing, re-grouping, transport and change of housing. New technical approaches for adequate piglet nestings should be evaluated (infrared radiation, alignment within pen, design). Stress factors can be semi-quantified on farms using husbandry advisory tools developed for risk assessment for tail biting.

Gilt management

The health status of sows and gilts might be different and in general colostral IgG concentrations are higher in multiparous sows than in first parity sows. For this reason efforts should not only focus on sows´ health status, but also onto gilt origin (optimal only one with known health status), selection and rearing, quarantine, acclimatization period, housing and the replacement rate in the herd. To have always complete farrowing groups to fulfill all-in-all-out in the farrowing unit, the insemination rate should be adapted to the farrowing rate, so that full groups consists of sows after weaning, sows which returned to oestrus and gilts. During the acclimatization period a tight contact between old sows and gilts should be achieved step-wise to guarantee an immunization with the herds microflora already in replacement sows.

Colostrum

Colostral IgG as well as maternal immune cells confers passive immunity to infectious diseases to newborn piglets. A direct correlation between newborn mortality and plasma immunoglobulin G has been found. In addition, milk and colostrum contain bioactive factors, as growth factors or components of the innate immune system, e.g. antimicrobial peptides. Sows´ colostrum production is not proportional to the number of born piglets, so that colostrum deficiency often occur in large litters. Cross-fostering and split-suckling can be necessary. A good piglet vitality (birth weight) is a precondition for adequate udder stimulation and colostrum/milk extraction. Additionally, an adequate colostrum uptake is necessary for gut maturation

Piglets gut health

The pigs ability to combat infection is dependend on gut colonization by commensal microbes after birth. Intestinal epithelial cells and Paneth cells have a barrier function, including antimicrobial peptide secretion, lectin- and NOD2 expression after stimulation by bacteria. Innate immune signalling in the gut induced by commensal microorganisms contributes to the development and function of the whole immune system. Also immune cells in other body compartments are affected by components of the microbiota which have been translocated into the circulation.

The negative effect of antibiotic administration in early life onto the gut microbiota (long-lasting disturbance of gut ecosystem, effect onto butyrate-producing bacteria) and therefore onto the piglets´ immune system should be evaluated and related to the benefit of the treatment (Janczyk et al. 2007). In parallel, the economic benefit of gut health stabilizing measures as the feeding of pro- and prebiotics or an environmental inoculation with specific bacteria should be studied.

Overall strategy

1. To figure out clearly the economic impact of disease and the economic benefit of improved management (consequent performance of specific management measures). Sophisticated calculation tools hast to be elaborated and provided for veterinarians and farmers in the field.
2. To enforce the consequent execution of selected management and vaccination strategies specific for the farm –better less measures which were consequently implemented.

Mini-paper of reduction of antimicrobial use by improved management practice (Cleaning & Disinfection)

Miguel Higuera

Introduction

Key words: **biosecurity, reinfection, cleaning, disinfection, pest control**.

Cleaning & Disinfection (C&D) plan has to take part in every sanitary procedure in the farm and should be carried out conscientiously with a good procedure and in a correct way.

C&D plan is linked with Biosecurity protocols, and how a farmer can improve the internal biosecurity (J. Casal, 2007). With a well-established protocol of C&D we can expect a reduction in the amount of diseases, infected farms and a general improvement in animal health due to a lower infection pressure.

It is well known that a high standard of C&D plan is an effective way to break the on farm cycle of reinfection with infectious diseases, mainly enteric diseases. Every health program needs to prevent pathogens entering (external biosecurity), to prevent pathogens spread (internal biosecurity) and reinfection (C&D) of healthy animal by contaminated buildings.

Unfortunately, for many farmers C&D is considered a low category task. This perception is due to the lack of improvement in cleaning technics, lack of new products and the lack of control measures in order to be sure the job is correctly done. (P. Alarcon, 2013)

But in a positive way, more and more specialized farmer have known that buildings can become "pig sick" and continued use con bring about a steady decline in health and performance (John D. Mackinnon, 2005).

The objectives of clean and disinfect the farm buildings are:

- Remove pathogens, dust and endotoxin from the environment
- Eliminate infection flows through the routes pig-to-pig, carrier-to-carrier and carrier-to-pig (G. Merialdi, 2013)
- Remove the transmission of infectious agents to the next batch of pigs from contaminated buildings and equipment with feces, urine, and infected manure.
- Remove the survival of infectious agents in biological niches such as water supply, feed bins, etc…
- Take the opportunity to repair, improve or replace the defective or damaged equipment, soil, etc…

Gaps

- Cleaning and disinfection programs are used as routine in pig herd, however there is a lack in a consistent and well establish performance.
- Buildings. Easy clean and disinfection materials are needed to improve the task performance
- Production system. All in / all out. Terminal disinfection (when there isn't any pig present) is better that continuous disinfection (with the presence of animals).
- Technology. New technologies to C&D and new products.
- Lack of knowledge about transmission of diseases (and resistances) coming from infected manure.

Solutions / Possibilities

- Training
  - Information
  - Training
- Production:
  - Design of farm facilities
  - 3-4-5 weeks batch system.
  - Management of retarded pigs.
  - All in / all out
  - …
- Technologies:
  - Equipment. Cleaning and disinfection equipment.
  - Auto-clean rooms
  - Save-water systems
  - Prevention of contamination: environment, land and water.
- Products:
  - No corrosive
  - No irritant
  - Spectrum of action
  - For use in surfaces and air
  - Time of action
- Control:
  - Rapid pathogen detection test
  - Control indicators.

References

J. Casal, A. De Manuel, E. Mateu, M. Martin. 2007. Biosecurity measures on swine farms in Spain: Perceptions by farmers and their relationship to current on-farm measures. Preventive Veterinary Medicine. Nov 2007. Vol 82, 1.2, Pages 138-150

P. Alarcon, B. Wieland, A. Mateus, C. Dewberry. 2013. Pig farmers' perception, attitudes, influences and management of information in the decision-making process for disease control. Preventive Veterinary Medicine. In press

John D. Mackinnon. 2005. Cleaning and Disinfection of pig herds. www.3tres3.com

G. Merialdi, E. Galletti, S. Guanzzetti, C. Rosignoli, G. Alborali, A. Battisti, A. Franco, P. Bonilauri, G. Rugna, P. Martelli. 2013. Environmental methicillin-resistant *Staphylococcus aureus* contamination in pig herds in relation to the productive phase and application of cleaning and disinfection. Research in Veterinary Science, 94, 3. Pages 425-427

Improving the hygiene of drinking water in pig facilities to reduce the application of antibiotics and to avoid the development of resistant bacteria

Nicole Kemper

Introduction

Various factors including the concentrations of different chemical compounds and microbial contaminations affect the quality of drinking water for livestock. The chemical and microbial composition of drinking water in pig facilities is mainly influenced by the source (e.g. well water, pipeline water, surface water), by the water supplying system and by hygienic measures applied to clean the supplying system. **Water of low quality** can affect the health of pigs, can be a source of infectious agents and can reduce the efficacy of antibiotics given via the water supplying systems. Furthermore, resistant bacteria may be generated especially by gen transfer in biofilms **in contaminated pipelines**. To guarantee the therapeutic effectiveness of antibiotics (used reasonably) in drinking water, and to avoid an unnecessary generation of antibiotic resistant bacteria in the water supplying system it is necessary **to improve and to control the drinking water hygiene**.

Solutions/possibilities

First of all efforts should be made to convince the farmers that the control, and if necessary the improvement of the drinking water quality, has benefits for the animals, the production and in the end for the consumer. Because the literature which demonstrates the risks and the disadvantages from a low quality drinking water in practice is considerable rare, it is suggested to intensify the research activities in this field. Hygienic indicators such as specific bacteria and important chemical factors Hygiene should be defined. Research activities should include the stability of drugs, especially of new designed drugs, in practice. Furthermore, concepts should be established on farms, which delivers a good water quality from the source to the end of pipelines. Such concepts should include:

- The periodical control of the chemical and microbiological water quality of the source (incoming water) and at the end of pipelines (water taken up by the pigs)
- If repeated analysis results in a low quality drinking water, the problem should be analyzed by experts
- Technical solutions (e.g. filtration, oxidation, osmosis) should be considered to ensure or to improve the water quality
- Cleaning and disinfection measures to purify the water supplying system should be checked
- Periodic or continuous chemical or physical treatments to enhance the drinking water quality
- An optimized design (materials, flow velocity, options for treatment) of the water supplying systems for the specific farm should be considered when new installations are necessary or when new farms are built

To ensure a high quality of drinking water the collaboration of experts from different fields are necessary. For example, engineers, hygiene experts, veterinarians, drug designers and at last the farmers should intensify the exchange of their experiences to establish an optimized water supply for farm animals. An optimized system and healthier animals lead to less antibiotic treatments, avoid the development of unwanted resistant bacteria and guarantee an effective treatment in cases where antibiotics are still needed.

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Reduction of antimicrobial use in pig husbandry by reduction of stress

Marion Kluivers

Introduction

Health can be defined as the ability of the animal to adapt to changing circumstances, without impairment of health or welfare: 'Health is the ability to adapt' (The Lancet, 2009). In stress physiology, homeostasis exists when an animal is in balance with its environment. When the situation changes, the animal will adapt and reaches a new balance (allostasis). When the ability to adapt is insufficient, allostatic overload occurs. When drawing a parallel between stress physiology (welfare) and health, a healthy animal is in balance with its environment (including infectious agents) and able to respond to changes by reaching a new balance. In case of allostatic overload, however, disease can/will occur. Resilience and robustness are often used terms to describe the capacity of the animal to adapt. Stressors challenge the resilience of the animal. Transitions are major causes of stress in pig husbandry and thereby influence the resilience of the animal. Major transitions in a pigs life are: birth, weaning, moving to a new environment, transportation and slaughter. Antibiotic use in pig husbandry is often associated with these transitions, weaning is considered the most critical transition (King and Pluske, 2003) and associated with high antibiotic use.

Solutions/possibilities

Means to influence the stress experienced by animals are (amongst others):

- Zootechnical circumstances (including the possibility to perform natural behaviour)
- Management of transitions (including birth)

Existing solutions/possibilities:

- Keeping piglets in the same pen after weaning (Fels *et al.*, 2012)
- Providing suckling piglets a more complex environment; a more complex environment results in better feed intake before and after weaning and therefore better growth (Oostindjer *et al.*, 2011b)
- Using positive handling to enhance welfare and growth (and possibly thereby also health) (Hemsworth *et al.*, 1981)

Partly developed solutions:

- Keeping litters together, no mixing of social groups at a later age (including transport and at slaughter)
- Reducing the number of husbandry procedures (i.e. castration, tail docking) to prevent infection and pain/stress
- Increasing feed intake before and after weaning, for example with the use of aromas

New solutions:

- Keeping litters together from birth to slaughter (including transportation) (Hayne and Gonyou, 2006, Fels *et al.*, 2012)
- Designing new husbandry systems that enhance welfare and limit health threats

More research is needed regarding:

- Critical points in early life that influence health (hence antibiotic use) and production in later life; sufficient colostrum intake provides better growth from 3 weeks of age onward and possibly even after weaning (Devillers *et al.*, 2011)
- The influence of the possibility to perform natural behaviour on resilience, welfare and disease occurrence
- Early detection of (the threat of) allostatic overload and/or disease

References

Devillers N, Le Dividich J and Prunier A 2011. Influence of colostrum intake on piglet survival and immunity Animal 5, 1605-1612.

Fels M, Hoy S and Hartung J 2012. Influence of origin litter on social rank, agonistic behaviour and growth performance of piglets after weaning. Applied Animal Behaviour Science.

Hayne SM and Gonyou HW 2006. Behavioural uniformity or diversity? Effects on behaviour and performance following regrouping in pigs. Applied Animal Behaviour Science 98, 28-44.

Hemsworth PH, Barnett JL and Hansen C 1981. The influence of handling by humans on the behavior, growth, and corticosteroids in the juvenile female pig. Hormones and Behavior 15, 396-403.

King RH and Pluske JR 2003. Nutritional management of the pig in preparation for weaning. In Weaning the pig. Concepts and consequences (eds. JR Pluske, J Le Dividich and MWA Verstegen), pp. 37-52. , Wageningen Academic Publishers, Wageningen, The Netherlands.

Oostindjer M, Mas-Munoz J, van den Brand H, Kemp B and Bolhuis JE 2011b. Maternal presence and environmental enrichment affect food neophobia of piglets. Biol. Lett. 7, 19-22

The Lancet 2009. What is health? The ability to adapt. The Lancet 373, 781.

RESPONSIBLE USE OF ANTIMICROBIALS IN PIG PRODUCTION

Thomas Lemoine

Introduction

Antibiotics are prescribed medications designed to fight illnesses caused by bacteria. Their use in both human and veterinary medicine is responsible of the rise of antimicrobial resistance. This natural phenomenon is an important public health issue. The challenge for farmers is to reduce their antibiotics use for a sustainable management of health. Concepts have emerged as the Responsible Use of medicines which means: “using medicines as little as possible and as much as necessary”. This implies to find practical strategies to reduce the need to use antimicrobials on pig farms.

Solutions and possibilities

1. There are existing **guidelines** on how to prevent diseases and limit the risk. For example, RUMA has published a full guideline on responsible use of antimicrobials in pig production (see references). The respect of fundamental rules which can be applied in every farms is the first step: vaccination, easy measures of biosecurity (no overcharging, segmentation, change of clothes, cleaning/disinfection…), avoid stress, good hygiene and nutrition. Some aspects remain underestimated as quality of water, management of dead animals and housing/management of a quarantine.

Improved biosecurity have positive impact on herd health and is a way to a responsible use of antimicrobials. The problem is that even if most farmers are aware of good practices some still not use them. The need or benefits are not always well understood or obstacles to implement measures are not well identified. There is no unique or magic solution to reduce the antimicrobial use which can be applied in all farms. It remains in a lot of strategies and good practices and depend on the management and health status of each farms. A support is often required and should combine the farmer, veterinarian and advisors.

2. Means to **encourage a change in practic**e are rising. In Denmark, a “yellow card” is given if the farmer uses antimicrobials in a quantity two times higher than the national average. Even if it can be seen as a penalty for farmers, it has led to a reduction in antimicrobial use. In France, a pig producer group has decided this year to create a new project: “the production of pigs without antibiotic”. Farmers will receive an added value if they answer the specifications (not communicated yet). Here, the question on how the consumer will consider other farmers is an issue.

Another point is the **development of tools** which helps to:

- **monitoring the health** at farm level : for example cough monitoring system to increase reactivity in case of disease or scoring systems (for biosecurity, diseases…). Sanitary organisms are also trying to create chartes to ensure a collective protection of farmers: in the studied case, the goal is to protect negative farms from PRRS by implementing biosecurity measures.
- **provide an accurate medication**. These dosing systems (water or feeding system) permit to avoid an overdose or underdose of antimicrobials which can make matters worse and increase antibioresistance. Some system can be added to existent distribution and calculates the dose required according to the food quantity ingested. For water, the dosing pump is

more and more used to act rapidly on several animals and sometimes replace feed supplement but not enough attention is paid to the flow and accuracy.

The evaluation of health status in farm is thus important and ways to control it should be promoted. But the economic implications of this responsible usage have to be also evaluated to create interest.

3. In research, a new dimension is given **including the social behavior** of human. Indeed, the requirements for a change in practice are not well known and remain complex. In France, a project lead by INRA is trying to link the practical usage of antimicrobials in farms to all the actors: farmers, veterinarians and advisors. Interaction between social, economic and technical factors will be studied. The goal is to identify the trajectory of change in practice of farmers who are using less and less antibiotics.

Another point is **the evaluation of practices of breeders and risk factors** (including the sow's management). Some farmers choose to reduce their use of antimicrobials but sometimes without having a sufficient knowledge. As mentioned in the discussions, the Prohealth Project will probably bring ideas on risk factors and best practices in farms. One of our experimental station will be used in this project to study piglet's neonatal mortality (according to housing, nutrition, practices…).

There is an existing role of nutrition on health. The prevention by secured food formulation, added yeasts or acids particularly at critical stages as weaning and importance of piglet's consumption of colostrum is generally recognized. However, the efficacy of additives as prebiotics, probiotics, clays is not well established or linked to reduction of antimicrobials use and need further research. In biologic production, no or very few antibiotics are used and some reflections are under way on the importance of alimentary transitions and rationing in post weaning period.

References

http://www.epruma.eu/

http://www.ruma.org.uk/pigs.htm

Responsible use of antimicrobials in pig production - full guideline

Changing human behavior and motivation factors thereby reducing antibiotic consumption

Annette Cleveland Nielsen, DVFA, Denmark

Introduction

The main goal in reduction of antibiotic consumption in animals must be to secure public health by reducing the selection pressure and resistance threat, especially from critical resistant bacteria, enabling effective treatment of bacterial infections in humans - also in the future (Arrestrup et al.,2001)(EFSA, 2011). Another goal is securing animal welfare and a fairly cheap human food supply.

Human behaviour is a key factor in altering the limiting factors for reducing antibiotic usage in swine production. Changing behaviour, thereby optimizing animal health and welfare in herds or changing motivation factors for vets and farmers should be able to reduce antibiotic consumption.

Human behaviour can be changed through awareness and motivation. In order to raise awareness among farmers and veterinarians one needs to do risk communication and make people aware of their contribution to a problem and their contribution to solving the problem. Concerning motivation, one need to understand *what motivates an action and how strong a motivator the action is, in order to alter the motivation or find a substitute for a contra productive motivator*. In order to be able to do risk communication on antibiotic consumption one has to begin with measuring the consumption. In order to be able to benchmark and compare consumption one has to standardize measurements for instance in ADDkg with the same ADD methods used (Stege et al., 2003) (Jensen et al., 2004). Comparisons between MS can be relatively easy based on a sample of herds, as it is done in the Netherlands in MARAN enabling political awareness, thresholds and motivation to reduce consumption. Comparison between herds and benchmarking of herds enabling risk communication to farmers, thereby raising awareness and motivation to reduce antibiotics, can also be done fairly simple without fancy databases, but using simple spread sheets calculating ADD´s from usage data for instance from farmers **billing** systems. The farmers can then benchmark themselves against the national threshold values set from the national sample of herds and calculated thresholds. A carrot or motivator for the farmers could be an improved production economy by a changed management behaviour reducing the need for antibiotics through reduced disease prevalence and optimized biosecurity.

For vets, money earned from selling antibiotics is a strong contra productive motivation factor for reducing prescriptions of antibiotics and a substitute for this ought to be found in order to reduce this and in the same time secure the vets earnings.

Topic: Attitudes towards antimicrobial usage among veterinarians and farmers

Solutions/possibilities

Existing/tested:

- **Decoupling prescription and sales of antibiotics from vets to farmers**

Money is a very strong motivator in human behaviour and having 40-70 % of your income as a vet linked to your sale of antibiotics is a very strong motivator for <u>not</u> reducing antibiotic usage or finding alternatives or advice in altering biosecurity and management factors.

Main advantages:

- done in the Nordic countries for decades and will result in a 40-50% decrease in usage,
- will force the vet to give better herd health advices to farmers and earn his money as an advisor in health and changed management and biosecurity – leading to better food safety and biosecurity
- will make the farmer a better farmer, who will earn more money in the long run, by having animals in a better health and welfare status due to better biosecurity and management – cases in Ireland of farmers not wanting prescribing vets but only health advisor vets
- will raise awareness between farmers to other farmers and among vets in own usage and thereby their contribution to the problem/solution, as seen in the Netherlands and Denmark after the political goals for reduction was enforced

Down sides are, that *vets might be worried of not earning the same amount of money by 'just' advising in health and management.* A solution could be mandatory regular vet visits as seen in the Northern countries and the Netherlands. A side bonus would be better surveillance/contingency of contagious animal diseases.

Attention should be given to conduct risk communication and discussions of solutions between vets and farmers in an organised manner for instance through stakeholders association meetings, courses etc.

Partly developed and effective:

Comparing usage in swine production in ADDkg in all MS and ADD per pig between herds and setting signal and action thresholds for herds plus setting political goals

DK and NL have done benchmarking of herds and have set political goals for reduction of antibiotics. This is done on the basis of measuring ADD in country based standard weight animals in country based standard age-groups. This is possible in all MS, also MS without database data on antibiotic consumption. Usage data for a national measurement can be obtained from a sample of herd data from representative herds on their consumption in kg antibiotics in a year and the numbers of pigs in the different age-groups in the same time span. This is done in the NL on a sample of only approx. 110 swine herds in the MARAN data. In DK all swine herds in the country is used and in SDa data in the NL approx. 4000 herds are sampled, but the comparisons between DK and NL is based on MARAN data with a relative small sample size used for calculation of national measures. Usage data on the herd level and for benchmarking between herds, measurements of ADD/pigs at risk/year can be done using a simple spread sheet calculation for ADD´s and data on pigs at risk can be obtained from production data.

In Denmark (DK) and the Netherlands (NL) usage has been measured in ADD (Animal Daily Doses[1]), but unfortunately not in ADDkg in both MS and not using the same standard weight for animals or standard age-groups in calculation of ADD´s, which ought to be done in order to be able to compare between MS.

[1] **Defined Animal Daily Dose (ADD and ADDkg).**
This is an assumed average daily dose per animal, defined as the daily maintenance dose for a drug used for its main indication in a specified species. The dose is defined for a "standard animal", i.e. an animal with an estimated average weight within a specified age group.
The ADDkg is the ADD per kg animal. Consumption calculated in ADDkg allows summation of consumption across different age groups and species.

funded by European Commission

If one uses ADDkg to compare between MS, instead of kg active substance, as in the ESVAC data, then the differences in potency of different antibiotics is cleared. But when using ADDkg one has to decide to measure only the active compound in a drug or both the salt and the active compound in calculation of ADDkg´s in order to be able to compare.

The comparison between MS could be done in ADDkg, ie. same ADD calculations for all antibiotics in all MS and measured in amounts of ADD per kilogram of pigs instead of in only kg active substances, taking differences in antibiotics used and their potency into account. The ADDkg in the single herds and on a national scale can be calculated from a simple spread sheet, where you have the amounts of kg active component in the drugs in the different ATC- groups of antibiotics and the ADD calculations for the drugs. You can also compare consumption regardless of animal age-groups, when using ADDkg.

Benchmarking threshold signal levels (70 % of action level in DK and different in the NL) and action levels (yellow card level in DK and action level in NL) can be set at individual MS levels appropriate for that MS and political reduction policy. This is done in the NL (SDa data) and in DK (VetStat data) as follows:

Sows **Signal / Action threshold**	**Slaughter pigs** **Signal/ Action threshold**
DK >3,01 / DK > 4,3 **NL 10-22 / NL > 22**	**DK > 4,13 / DK > 5,9** **NL 10-13 / NL > 13**

When benchmarking is used one has to know the consumption in relation to number of animals at risk. As swine is divided into different age-groups one has to have a standard weight for an animal in the different age-group and use this when one is calculating ADD/per pig in an age-group. **Risk communication of signal and action levels and best practice results of management etc. can be given to farmers from their vets or through the internet.** In DK a green, yellow and red signalling system over the internet is used to give the farmer risk communication on his antibiotic level and the mortality in the age-groups as well (SundReg). The information is given to him directly when he enters the DVFA databases for other purposes and he can see if his herd is green=OK level, yellow=signal level or red=action level. When using data on the herd level ADD and standard weights of pigs in different age-groups have to be the same in all MS in order to compare between MS or within MS when benchmarking herds.

Main advantages of comparing and measuring usage:

- will result in a 10-50% decrease in usage, as seen in DK and NL,
- will enable comparison between MS when ADDkg is used
- will enable comparison between MS and between herds IF same standard animals, age-groups, SPC values and active compound only are used for ADD calculations
- will enable politicians to set reduction targets and signal and action threshold levels from data on ADD/pig/year from a fairly small sample of herds in MS
- will enable other farmers – on a voluntary basis - to measure their ADD/pig/year and benchmark themselves to the political action levels, when they know the ADD calculations and from their billing system know the amounts and type of antibiotics used and from their

sow or slaughter data can calculate the numbers of pigs at risk in the same time span- **a simple spread sheet calculation for ADD can do it for them.**

- This transfer of knowledge to farmers, vets and advisors will raise awareness to farmers and vets on their contribution to the antibiotic problem and how they can contribute to solve the problem. This ought to motivate them towards a reduced use.

Down sides:

Farmers must have computer access and be able to use a spread sheet or their vets must be able to.

Attention:

Attention should be given to conduct risk communication and discussions of solutions between vets and farmers in an organised manner for instance through stakeholders association meetings, courses etc.

Further testing should be done in economic benefits at farm level by changing management factors reducing antibiotic consumption by changing animal health and welfare and saving money and work hours in treatment of animals and vet visits. And this information should be given to farmers in order to motivate them to change management in their farm due to economics.

Topic: Specific alternatives to antibiotics

Solutions/possibilities

Existing/tested:

- **ZnO treatment as an supplement or alternative to antibiotics**

Pigs are treated with 2500 ppm ZnO in the first 14 days after weaning. Farmers think this reduced the antibiotics needed with 50-70 %, but they still use a lot of antibiotics at weaning, so maybe it is just a precautionary treatment with either antibiotics or ZnO !

Down sides:

An environmental issue as ZnO is a heavy methal. Also some concern, but not demonstrated, that there could be a link between ZnO and MRSA.

New

- **Resistance load and type on the herd level and its contribution to public health**

Maybe not an alternative to antibiotics, but research in which kind of treatment and which kind of administration route will develop the lowest or highest load of resistant bacteria within a herd. There are two research projects on the topic in DK: Mini-resist at CU-LIFE and Resist at DTU-Food. After all, the amounts of antibiotics used are not the most crucial issue in reducing public health concerns due to antibiotic usage, but the resistance the usage creates, is the crucial issue. And there might be a future where we are not measuring amounts used within a herd, but the resistance load and type the individual herd contributes with. By altering the farmer and vets treatments of the pigs, through information and awareness to the farmer and vet on better treatment possibilities and administration routes, thereby securing public health by a lower resistance load, but still giving effective treatment of the pigs, is the issue. An example could be a treatment with a high initial dosage of parenteral administered GI antibiotics, but a shorter treatment period.

Topic: General enhancement of animal health and welfare

Solutions/possibilities

New

- **Welfare index in swine herds describing, among else, the link between herd animal welfare and consumption of antibiotics**

A 4 year research project between several universities and the DVFA in DK is being conducted, where all kind of database data from DVFA´s veterinary datawarehouse (Cleveland Nielsen, 2011) is used including meat control data and supplying with herd data on the animal level plus resource level are being used to develop an index describing animal welfare. This index on the herd level can be compared with the ADD per pig on the herd level in order to describe associations between antibiotic usage and welfare of pigs. The project is politically driven due to concerns for animal welfare in pig herds when antibiotic use is being reduced due to the threshold values for antibiotic consumption in the yellow card system and in order to have an optimal control of both animal welfare and antibiotic consumption. The issue for the farmer is, that he can see how his is doing animal welfare wise and compared to his treatments.

References

Aarestrup FM, Seyfarth AM, Emborg HD, Pedersen K, Hendriksen RS, Bager F. Effect of abolishment of the use of antimicrobial agents for growth promotion on occurrence of antimicrobial resistance in fecal enterococci from food animals in Denmark. Antimicrob Agents Chemother. 2001;45(7):2054-9.

EFSA Panel on Biological Hazards (BIOHAZ). Scientific Opinion on the public health risks of bacterial strains producing extended-spectrum β-lactamases and/or AmpC β-lactamases in food and food-producing animals. EFSA Journal 2011; 9(8):2322 [95 pp.].

Stege H, Bager F, Jacobsen E, Thougaard A. VETSTAT-the Danish system for surveillance of the veterinary use of drugs for production animals. Prev Vet Med. 2003 Mar 20;57(3):105-15.

Jensen VF, Jacobsen E, Bager F. Veterinary antimicrobial-usage statistics based on standardized measures of dosage. Prev Vet Med. 2004 Jul 16;64(2-4):201-15. Review.

Cleveland Nielsen, A. Data warehouse for assessing animal health, welfare, risk management and – communication. Acta Vet Scand. 2011; 53(Suppl 1): S3.

AREA 2

Alternatives treatments

Mini-paper on early warning or benchmark systems

Jürgen Harlizius

Introduction

On one side it is very important to detect upcoming emerging and/or new diseases very early on the other side we want to reduce the antibiotics. We should use an early warning and a benchmark system for both.

Solutions and possibilities

1. **Mortality rate**
   Central database about the mortality rate/farm. In Germany it`s by now common that all dead animals in a district are collected from one specialist company. With a threshold/farm.
   But there is also an on farm monitoring:
   In the case of high mortality, abortion and high fever on the farm without or with unclear diagnosis further diagnostic has to be done (gross sections and/or blood sampels)
2. **ADD/PIG/Farm**
   Farms above a threshold are forced to make an action plan (DK Yellow card system, D New law restrictions)
3. **Results of meat inspection**
   Benchmarks for animal health and welfare and consumer protection. Farm visits from the animal health service on farms above a threshold
4. **Further obligatory results**
   In D Salmonella serology and classification

References

- Blaha et al.,
- Nielsen et al.

funded by European Commission

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Thomas Lemoine

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Solutions and possibilities

1. There are existing **guidelines** on how to prevent diseases and limit the risk. For example, RUMA has published a full guideline on responsible use of antimicrobials in pig production (see references). The respect of fundamental rules which can be applied in every farms is the first step: vaccination, easy measures of biosecurity (no overcharging, segmentation, change of clothes, cleaning/disinfection…), avoid stress, good hygiene and nutrition. Some aspects remain underestimated as quality of water, management of dead animals and housing/management of a quarantine.

Improved biosecurity have positive impact on herd health and is a way to a responsible use of antimicrobials. The problem is that even if most farmers are aware of good practices some still not use them. The need or benefits are not always well understood or obstacles to implement measures are not well identified. There is no unique or magic solution to reduce the antimicrobial use which can be applied in all farms. It remains in a lot of strategies and good practices and depend on the management and health status of each farms. A support is often required and should combine the farmer, veterinarian and advisors.

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Another point is the **development of tools** which helps to:

- **monitoring the health** at farm level : for example cough monitoring system to increase reactivity in case of disease or scoring systems (for biosecurity, diseases…). Sanitary organisms are also trying to create chartes to ensure a collective protection of farmers: in the studied case, the goal is to protect negative farms from PRRS by implementing biosecurity measures.
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Topic: Attitudes towards antimicrobial usage among veterinarians and farmers

Solutions/possibilities

Existing/tested:

- **Decoupling prescription and sales of antibiotics from vets to farmers**

Money is a very strong motivator in human behaviour and having 40-70 % of your income as a vet linked to your sale of antibiotics is a very strong motivator for <u>not</u> reducing antibiotic usage or finding alternatives or advice in altering biosecurity and management factors.

funded by European Commission

Main advantages:

- done in the Nordic countries for decades and will result in a 40-50% decrease in usage,
- will force the vet to give better herd health advices to farmers and earn his money as an advisor in health and changed management and biosecurity – leading to better food safety and biosecurity
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Down sides are, that *vets might be worried of not earning the same amount of money by 'just' advising in health and management.* A solution could be mandatory regular vet visits as seen in the Northern countries and the Netherlands. A side bonus would be better surveillance/contingency of contagious animal diseases.

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Attention:

Attention should be given to conduct risk communication and discussions of solutions between vets and farmers in an organised manner for instance through stakeholders association meetings, courses etc.

Further testing should be done in economic benefits at farm level by changing management factors reducing antibiotic consumption by changing animal health and welfare and saving money and work hours in treatment of animals and vet visits. And this information should be given to farmers in order to motivate them to change management in their farm due to economics.

Topic: Specific alternatives to antibiotics

Solutions/possibilities

Existing/tested:

- **ZnO treatment as an supplement or alternative to antibiotics**

Pigs are treated with 2500 ppm ZnO in the first 14 days after weaning. Farmers think this reduced the antibiotics needed with 50-70 %, but they still use a lot of antibiotics at weaning, so maybe it is just a precautionary treatment with either antibiotics or ZnO !

Down sides:

An environmental issue as ZnO is a heavy methal. Also some concern, but not demonstrated, that there could be a link between ZnO and MRSA.

New

- **Resistance load and type on the herd level and its contribution to public health**

Maybe not an alternative to antibiotics, but research in which kind of treatment and which kind of administration route will develop the lowest or highest load of resistant bacteria within a herd. There are two research projects on the topic in DK: Mini-resist at CU-LIFE and Resist at DTU-Food. After all, the amounts of antibiotics used are not the most crucial issue in reducing public health concerns due to antibiotic usage, but the resistance the usage creates, is the crucial issue. And there might be a future where we are not measuring amounts used within a herd, but the resistance load and type the individual herd contributes with. By altering the farmer and vets treatments of the pigs, through information and awareness to the farmer and vet on better treatment possibilities and administration routes, thereby securing public health by a lower resistance load, but still giving effective treatment of the pigs, is the issue. An example could be a treatment with a high initial dosage of parenteral administered GI antibiotics, but a shorter treatment period.

Topic: General enhancement of animal health and welfare

Solutions/possibilities

New

- **Welfare index in swine herds describing, among else, the link between herd animal welfare and consumption of antibiotics**

A 4 year research project between several universities and the DVFA in DK is being conducted, where all kind of database data from DVFA´s veterinary datawarehouse (Cleveland Nielsen, 2011) is used including meat control data and supplying with herd data on the animal level plus resource level are being used to develop an index describing animal welfare. This index on the herd level can be compared with the ADD per pig on the herd level in order to describe associations between antibiotic usage and welfare of pigs. The project is politically driven due to concerns for animal welfare in pig herds when antibiotic use is being reduced due to the threshold values for antibiotic consumption in the yellow card system and in order to have an optimal control of both animal welfare and antibiotic consumption. The issue for the farmer is, that he can see how his is doing animal welfare wise and compared to his treatments.

References

Aarestrup FM, Seyfarth AM, Emborg HD, Pedersen K, Hendriksen RS, Bager F. Effect of abolishment of the use of antimicrobial agents for growth promotion on occurrence of antimicrobial resistance in fecal enterococci from food animals in Denmark. Antimicrob Agents Chemother. 2001;45(7):2054-9.

EFSA Panel on Biological Hazards (BIOHAZ). Scientific Opinion on the public health risks of bacterial strains producing extended-spectrum β-lactamases and/or AmpC β-lactamases in food and food-producing animals. EFSA Journal 2011; 9(8):2322 [95 pp.].

Stege H, Bager F, Jacobsen E, Thougaard A. VETSTAT-the Danish system for surveillance of the veterinary use of drugs for production animals. Prev Vet Med. 2003 Mar 20;57(3):105-15.

Jensen VF, Jacobsen E, Bager F. Veterinary antimicrobial-usage statistics based on standardized measures of dosage. Prev Vet Med. 2004 Jul 16;64(2-4):201-15. Review.

Cleveland Nielsen, A. Data warehouse for assessing animal health, welfare, risk management and – communication. Acta Vet Scand. 2011; 53(Suppl 1): S3.

Intestinal microbiota an health

Pedro Rubio

The existence of microbe free animals in nature is impossible as they must have a symbiotic association with microbes. Some years ago the holobiont concept was introduced to name the living being formed by the host and its microbiota.

The importance of the intestinal microbiota on the health is becoming more and more obvious. This fact is highlighted by the number of papers on this subject in PubMed that has suffered a huge increase, going from 496 in 2008 to 2494 in 2013.

The human being is the species in which the microbiota is best studied. The number of bacteria of the digestive microbiota in man is 100 times higher than the number of body cells and this bacterial microbiota has a number of genes 150 times higher than the human genes. Digestive microbiota has been named as the “forgotten organ” because it carries out a variety of functions which sustain health and, when disrupted, lead to disease. It is considered that the metabolic capacity of the digestive microbiota is similar or superior to that of the liver.

The intestinal microbiota is highly variable. In the human gut bacteria of between 500 and 1000 different species. The microbiota is also variable in relation to the time and the space that it occupies can be found. The microbiota of a lactating piglet is very different from that of a weaned or a fattening pig. There are also marked changes along the gastrointestinal tract. Both species and number of bacteria are significantly different from the stomach to the colon.

The intestinal microbiota has metabolic functions, such as the vitamins synthesis or the digestion of different feed components that are indigestible for the pig. The other important functions of the intestinal microbiota are the defense against pathogens and the stimulation of the development and maturity of the immune system.

Early life exposure to microbiota begins “in utero” and progresses gradually during the first weeks of life. In humans it is well known that this initial colonization largely determines the future of the immune response. Infants born by Caesarean section have a very different microbiota of infants born vaginally and this fact causes a deep impact in their immunological system. The microbial stimulus on intestinal mucosa specific receptors triggers off a series of events that are essential for the future immune response also in the piglet. The intestinal immune system also learns to distinguish between pathogens and symbiotic microbiota.

Once established, mature microbiota contributes to the health of pigs in several ways such as maintenance of the intestinal barrier, stimulating the secretion of IgA, producing short chain fatty acids and bacteriocins and competing for substrates and receptors.

Therefore the microbiota is of vital importance in the health of the pig. Many bacteria of the digestive microbiota have not been cultured so far, but the availability of DNA sequencing technologies and the reduction of their costs has enabled a great breakthrough over the last few years in the knowledge of the digestive microbiota and of its changes after different kinds of interventions.

The intestinal microbiota has a good resilience, but can change in a positive or a negative sense by different factors. The use, and especially the misuse, of antibiotics is the main origin of disturbances of intestinal microbiota and often leads to more severe disease.

Possibilities of intervention

It is possible to modify the microbiota in the right way in order to keep or recover the intestinal health so as to contribute to decrease or avoid the use of antibiotics.

There are specific diseases of the digestive tract in pig, as swine dysentery, but many of the digestive disorders at present affecting pig production are the so-called "dysbiosis", that has been defined as qualitative and quantitative changes in the intestinal flora, their metabolic activity and their local distribution. The colibacillosis and the different digestive infections by *Clostridium* spp. are dysbiosis.

It seems possible to treat or to prevent this dysbiosis restoring or maintaining the right equilibrium in the digestive microbiota. The main products used with this objective are **probiotics** and **prebiotics** and a combination of both (**symbiotics**). The "**parabiotic**" concept has been recently introduced to name the use of inactivated microbial cells or cell fractions to confer a health benefit to the host.

Probiotics are living microorganisms which, when administered in adequate amounts, provide a health benefits on the host. These health benefits are highly dependent on the bacterial strain and on the situation and the moment in which they are administered. The probiotic effects are attributed to the interaction of probiotics with other microorganisms (members of the microbiota or pathogens) or to the cross-talk of probiotics with host cells. LAB (lactic acid bacteria) are usually the main components of the probiotics.

Prebiotics are defined as components of the feed that are non-digestible by the host, that beneficially affect its health by selectively stimulating the growth and activity of beneficial of bacteria in the intestine, and symbiotics are a combination of a probiotic and a prebiotic with the aim of increasing the survival and activity of the probiotic "in vivo" as well as stimulating indigenous beneficial bacteria.

The knowledge on the effects of probiotics, prebiotics, synbiotics and parabiotics has increased and there are a numerous research papers on this subject, but the information concerning their impact on the health of the pig is still incomplete

It is important to increase the research on the efficiency of this products supported by the knowledge on their action mechanism. Genomic-based knowledge on the composition and functions of the gut microbiota as well as its disturbances allows for the selection of more specific products and to study their activity in deep at this moment.

The use of this types of products with a proven efficiency permits a reduction in the use of antibiotics in pig production

Vaccination contributes to responsible use of antibiotics in pig production

Dieter Schillinger

Introduction

We can anticipate on-going pressures for reducing antimicrobial use in pig production, even if there is no published risk assessment linking an increased risk of human clinical treatment failures with any specific antimicrobial use in food animals. However, if we assume that any reduction of antimicrobial use is desirable it seems logical to eliminate antimicrobial uses that are 'less necessary' or less justifiable in terms of benefiting animal health and welfare (P. Davis). The European Platform for the Responsible Use of Medicines in Animals (EPRUMA) defines responsible use as a key concept in ensuring appropriate use of antimicrobials which includes biosecurity, good housing, appropriate nutrition, regular monitoring of health and welfare, herd health plans, diagnosis and treatment under veterinary care, use of medicines according to instructions, and vaccination.

The Ana Rosbach report (EU Parliament Plenary 11.12.2012) underlines that to avoid massive over-use of antimicrobials, livestock farming, aquaculture and human medicine should focus on disease prevention. Also the European Commission's Action Plan against the rising threats from AMR covers seven areas of which one emphasizes preventing microbial infections and their spread - Action No 5 of the Road Map of the European Commission: Adoption of a proposal for an Animal Health Law, which will focus on prevention of diseases, reducing the use of antibiotics and replacing current animal health provisions based on disease control. The final proposal was adopted on May 6, 2013, and is currently in ordinary legislative procedure.

Biosecurity measures and vaccination programs are the main strategies to avoid infectious diseases and by doing so reducing antimicrobial consumption in pig production. MINAPIG has asked 111 pig health experts from 6 EU countries re the potential alternatives for antimicrobial use. The best average core was given for internal biosecurity and increased vaccination. Vaccinations are available for a number of bacterial and viral diseases that affect swine. But only for a few vaccines systematic research on the impact on antibiotic consumption has been carried on farm level.

Existing solutions underused by farmers which should be promoted

The Norwegian Atlantic salmon production is a great example for replacing antibiotics by vaccines. The introduction of the first injectable furunculosis vaccine in the early 1990's started the true revolution in the field of fish health management in the Norwegian Atlantic salmon production. This furunculosis vaccine was made multivalent in 1992, securing protection against three types of vibriosis in addition to furunculosis. More vaccine introductions followed. Vaccines enabled the disease-plagued industry to move from treatment with regular and wide spread use of antibiotics to prevention and protection through routine vaccination. Effective vaccines were probably the most important single factor in creating the possibility for the Norwegian aquaculture to grow the production but also to reduce its use of antibiotics by 99.8% per ton of trout and salmon produced, compared to the 1987 level.

Obviously, using vaccines to prevent disease rather than antibiotics is an easy way to reduce antibiotic usage. Here a first review on published data to what extent vaccination can reduce antibiotic usage in pig production.

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Buntgaard, H., et al. (2012)

"In a study conducted in Denmark on 20 farms, those using a live ***Laswonia intracellularis*** **vaccine** used less antibiotics than those that did not: 11.4 ADD per 100 weaned pigs versus 14.8."

Nerem, J. (2009)

"Use of 10 grams of dietary tylosin phosphate per pig was avoided by using ***Lawsonia intracellularis*** **vaccine** for prevention of proliferative enteropathy (PE). This study demonstrated that pork producers may change from routine use of finishing dietary antimicrobials to prevention of PE by vaccination without sacrificing performance. In addition, they may achieve an economic advantage."

Bak, H. and P.H. Rathkjen (2009)

"The pigs were included batch-wise in the study with every second batch being vaccinated against ***Lawsonia intracellularis***. In the vaccinated batches, the consumption of oxytetracycline to treat PE was reduced by 79%, with a significant lower number of pigs being treated."

Buntgaard, H. et al. (2013)

"The retrospective analysis demonstrates that the use of one dose ***PCV2*** **vaccine** at the time of weaning can control PCVD, improve performance, reduce antibiotic use and improve animal welfare. - Overall prevention of disease through vaccination addresses the environmental, social and economic requirements of modern pig farming and hence can be seen as a crucial element for a sustainable pork production."

Pejsak, Z. et al. (2010)

"In this farm acutely affected with PMWS, the efficacy of ***PCV2 vaccination*** was confirmed. The three vaccination programs gave good improvement in terms of mortality rates, growth, feed efficiency, number of antibiotic treatments."

Areas which need exploration

Autogenous vaccines are manufactured from the specific pathogenic bacteria isolated from a diseased pig. They are usually made under a licence for use only on that farm. They can be useful when serious disease outbreaks occur and standard commercial vaccines are not available. No information is available for the effects of autogenous vaccines on antibiotic consumption.

The global animal health vaccines market is in its growth phase. The factors responsible for the growth of the market include increasing incidences of zoonotic diseases in humans, growing prevalence of animal diseases and increasing investments by leading players and the search of alternatives for antibiotic treatment. Another factor driving the growth in this area is the continous innovation which lead to the launch of new products with the potential to reduce further the use of antibiotics in pig production. Newly launched vaccines should immediately be tested to measure their potential to reduce antibiotic consumption.

Today, proof of concept that vaccination reduces antibiotic consumption is available only for two diseases, PCV2 and Ileitis (as far as the author knows). Studies, demonstrating the effectiveness of replacing antibiotics by vaccines need to be carried out for other important pig diseases as well. These studies need to include an economic evaluation in order to have an additional argument for farmers to switch from antibiotics to vaccines.

Hindrances to replacing antibiotic treatments by vaccination:

- Vaccines are effective only against a specific disease (antibiotics have a wider efficacy spectrum).
- The creation of an effective vaccination programme for a farm needs a trustful and professional cooperation between vet and farmer.
- The choice of the right vaccine is based on continuous diagnostic measurements (cost).
- Farmers are trusting the routine use of antibiotics over many production cycles. Difficult to change this behaviour.
- Cost for vaccination programmes may be higher than routine use of antibiotics.
- Etc.

References

Bak, H. and Rathkjen, P.H. (2009): Reduced use of antimicrobials after vaccination of pigs against porcine proliferative enteropathy in a Danish SPF herd. Acta Veterinaria Scandinavica 51:1

Bundgaard, H., et al. (2012): How to reduce antimicrobial use in pig production. Proc. IPVS. Vol 1, 200

Bundgaard, H., et al. (2013): Vaccination significantly reduces use of antibiotics. PigProgress News, knowledge & career

Davies, P. (2013): In-feed antibiotics: some of the issues. The Pig Site; 14.11.2013

European Commission: Action Plan against antimicrobial resistance. 17.11.2011

European Commission: AMR Road Map

European Parliament (December 2012): The microbial challenge- rising threats from antimicrobial resistance

EC (2011) European Commission: Communication from the Commission to the European Parliament and the Council – Action plan against the rising threats from antimicrobial resistance

European Platform for the Responsible Use of Medicines in Animals: www.epruma.eu

MINAPIG (2013): Potential alternatives to antimicrobials in pig production based on perceived effectiveness, feasibility and return on investment. Poster, Safepork;

www.minapig.eu

Nerem, J. (2009): *Lawsonia intracellularis* vaccination as an alternative to dietary antimicrobial medication in finishing swine. Safe pork 2009, Québec, Canada

Pejsak, Z., et al. (2010): Efficacy of different protocols of vaccination against procine circoviurs type 2 (PCV2) in a farm affected by postweaning multisystemic wasting syndrome (PMWS). Comparative Immunology, Microbiology and Infectious Diseases, 33, e1-e5

AREA 3

Attitudes, information and human behaviour

funded by European Commission

RESPONSIBLE USE OF ANTIMICROBIALS IN PIG PRODUCTION

Thomas Lemoine

Introduction

Antibiotics are prescribed medications designed to fight illnesses caused by bacteria. Their use in both human and veterinary medicine is responsible of the rise of antimicrobial resistance. This natural phenomenon is an important public health issue. The challenge for farmers is to reduce their antibiotics use for a sustainable management of health. Concepts have emerged as the Responsible Use of medicines which means: “using medicines as little as possible and as much as necessary”. This implies to find practical strategies to reduce the need to use antimicrobials on pig farms.

Solutions and possibilities

1. There are existing **guidelines** on how to prevent diseases and limit the risk. For example, RUMA has published a full guideline on responsible use of antimicrobials in pig production (see references). The respect of fundamental rules which can be applied in every farms is the first step: vaccination, easy measures of biosecurity (no overcharging, segmentation, change of clothes, cleaning/disinfection…), avoid stress, good hygiene and nutrition. Some aspects remain underestimated as quality of water, management of dead animals and housing/management of a quarantine.

Improved biosecurity have positive impact on herd health and is a way to a responsible use of antimicrobials. The problem is that even if most farmers are aware of good practices some still not use them. The need or benefits are not always well understood or obstacles to implement measures are not well identified. There is no unique or magic solution to reduce the antimicrobial use which can be applied in all farms. It remains in a lot of strategies and good practices and depend on the management and health status of each farms. A support is often required and should combine the farmer, veterinarian and advisors.

2. Means to **encourage a change in practic**e are rising. In Denmark, a “yellow card” is given if the farmer uses antimicrobials in a quantity two times higher than the national average. Even if it can be seen as a penalty for farmers, it has led to a reduction in antimicrobial use. In France, a pig producer group has decided this year to create a new project: “the production of pigs without antibiotic”. Farmers will receive an added value if they answer the specifications (not communicated yet). Here, the question on how the consumer will consider other farmers is an issue.

Another point is the **development of tools** which helps to:

- **monitoring the health** at farm level : for example cough monitoring system to increase reactivity in case of disease or scoring systems (for biosecurity, diseases…). Sanitary organisms are also trying to create chartes to ensure a collective protection of farmers: in the studied case, the goal is to protect negative farms from PRRS by implementing biosecurity measures.
- **provide an accurate medication**. These dosing systems (water or feeding system) permit to avoid an overdose or underdose of antimicrobials which can make matters worse and increase antibioresistance. Some system can be added to existent distribution and calculates the dose required according to the food quantity ingested. For water, the dosing pump is

more and more used to act rapidly on several animals and sometimes replace feed supplement but not enough attention is paid to the flow and accuracy.

The evaluation of health status in farm is thus important and ways to control it should be promoted. But the economic implications of this responsible usage have to be also evaluated to create interest.

3. In research, a new dimension is given **including the social behavior** of human. Indeed, the requirements for a change in practice are not well known and remain complex. In France, a project lead by INRA is trying to link the practical usage of antimicrobials in farms to all the actors: farmers, veterinarians and advisors. Interaction between social, economic and technical factors will be studied. The goal is to identify the trajectory of change in practice of farmers who are using less and less antibiotics.

Another point is **the evaluation of practices of breeders and risk factors** (including the sow's management). Some farmers choose to reduce their use of antimicrobials but sometimes without having a sufficient knowledge. As mentioned in the discussions, the Prohealth Project will probably bring ideas on risk factors and best practices in farms. One of our experimental station will be used in this project to study piglet's neonatal mortality (according to housing, nutrition, practices…).

There is an existing role of nutrition on health. The prevention by secured food formulation, added yeasts or acids particularly at critical stages as weaning and importance of piglet's consumption of colostrum is generally recognized. However, the efficacy of additives as prebiotics, probiotics, clays is not well established or linked to reduction of antimicrobials use and need further research. In biologic production, no or very few antibiotics are used and some reflections are under way on the importance of alimentary transitions and rationing in post weaning period.

References

http://www.epruma.eu/

http://www.ruma.org.uk/pigs.htm

Responsible use of antimicrobials in pig production - full guideline

Changing human behavior and motivation factors thereby reducing antibiotic consumption

Annette Cleveland Nielsen, DVFA, Denmark

Introduction

The main goal in reduction of antibiotic consumption in animals must be to secure public health by reducing the selection pressure and resistance threat, especially from critical resistant bacteria, enabling effective treatment of bacterial infections in humans - also in the future (Arrestrup et al.,2001)(EFSA, 2011). Another goal is securing animal welfare and a fairly cheap human food supply.

Human behaviour is a key factor in altering the limiting factors for reducing antibiotic usage in swine production. Changing behaviour, thereby optimizing animal health and welfare in herds or changing motivation factors for vets and farmers should be able to reduce antibiotic consumption.

Human behaviour can be changed through awareness and motivation. In order to raise awareness among farmers and veterinarians one needs to do risk communication and make people aware of their contribution to a problem and their contribution to solving the problem. Concerning motivation, one need to understand *what motivates an action and how strong a motivator the action is, in order to alter the motivation or find a substitute for a contra productive motivator*. In order to be able to do risk communication on antibiotic consumption one has to begin with measuring the consumption. In order to be able to benchmark and compare consumption one has to standardize measurements for instance in ADDkg with the same ADD methods used (Stege et al., 2003) (Jensen et al., 2004). Comparisons between MS can be relatively easy based on a sample of herds, as it is done in the Netherlands in MARAN enabling political awareness, thresholds and motivation to reduce consumption. Comparison between herds and benchmarking of herds enabling risk communication to farmers, thereby raising awareness and motivation to reduce antibiotics, can also be done fairly simple without fancy databases, but using simple spread sheets calculating ADD´s from usage data for instance from farmers **billing** systems. The farmers can then benchmark themselves against the national threshold values set from the national sample of herds and calculated thresholds. A carrot or motivator for the farmers could be an improved production economy by a changed management behaviour reducing the need for antibiotics through reduced disease prevalence and optimized biosecurity.

For vets, money earned from selling antibiotics is a strong contra productive motivation factor for reducing prescriptions of antibiotics and a substitute for this ought to be found in order to reduce this and in the same time secure the vets earnings.

Topic: Attitudes towards antimicrobial usage among veterinarians and farmers

Solutions/possibilities

Existing/tested:

- **Decoupling prescription and sales of antibiotics from vets to farmers**

Money is a very strong motivator in human behaviour and having 40-70 % of your income as a vet linked to your sale of antibiotics is a very strong motivator for <u>not</u> reducing antibiotic usage or finding alternatives or advice in altering biosecurity and management factors.

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Main advantages:

- done in the Nordic countries for decades and will result in a 40-50% decrease in usage,
- will force the vet to give better herd health advices to farmers and earn his money as an advisor in health and changed management and biosecurity – leading to better food safety and biosecurity
- will make the farmer a better farmer, who will earn more money in the long run, by having animals in a better health and welfare status due to better biosecurity and management – cases in Ireland of farmers not wanting prescribing vets but only health advisor vets
- will raise awareness between farmers to other farmers and among vets in own usage and thereby their contribution to the problem/solution, as seen in the Netherlands and Denmark after the political goals for reduction was enforced

Down sides are, that *vets might be worried of not earning the same amount of money by 'just' advising in health and management.* A solution could be mandatory regular vet visits as seen in the Northern countries and the Netherlands. A side bonus would be better surveillance/contingency of contagious animal diseases.

Attention should be given to conduct risk communication and discussions of solutions between vets and farmers in an organised manner for instance through stakeholders association meetings, courses etc.

Partly developed and effective:

Comparing usage in swine production in ADDkg in all MS and ADD per pig between herds and setting signal and action thresholds for herds plus setting political goals

DK and NL have done benchmarking of herds and have set political goals for reduction of antibiotics. This is done on the basis of measuring ADD in country based standard weight animals in country based standard age-groups. This is possible in all MS, also MS without database data on antibiotic consumption. Usage data for a national measurement can be obtained from a sample of herd data from representative herds on their consumption in kg antibiotics in a year and the numbers of pigs in the different age-groups in the same time span. This is done in the NL on a sample of only approx. 110 swine herds in the MARAN data. In DK all swine herds in the country is used and in SDa data in the NL approx. 4000 herds are sampled, but the comparisons between DK and NL is based on MARAN data with a relative small sample size used for calculation of national measures. Usage data on the herd level and for benchmarking between herds, measurements of ADD/pigs at risk/year can be done using a simple spread sheet calculation for ADD´s and data on pigs at risk can be obtained from production data.

In Denmark (DK) and the Netherlands (NL) usage has been measured in ADD (Animal Daily Doses[3]), but unfortunately not in ADDkg in both MS and not using the same standard weight for animals or standard age-groups in calculation of ADD´s, which ought to be done in order to be able to compare between MS.

[3] **Defined Animal Daily Dose (ADD and ADDkg).**
This is an assumed average daily dose per animal, defined as the daily maintenance dose for a drug used for its main indication in a specified species. The dose is defined for a "standard animal", i.e. an animal with an estimated average weight within a specified age group.
The ADDkg is the ADD per kg animal. Consumption calculated in ADDkg allows summation of consumption across different age groups and species.

If one uses ADDkg to compare between MS, instead of kg active substance, as in the ESVAC data, then the differences in potency of different antibiotics is cleared. But when using ADDkg one has to decide to measure only the active compound in a drug or both the salt and the active compound in calculation of ADDkg´s in order to be able to compare.

The comparison between MS could be done in ADDkg, ie. same ADD calculations for all antibiotics in all MS and measured in amounts of ADD per kilogram of pigs instead of in only kg active substances, taking differences in antibiotics used and their potency into account. The ADDkg in the single herds and on a national scale can be calculated from a simple spread sheet, where you have the amounts of kg active component in the drugs in the different ATC- groups of antibiotics and the ADD calculations for the drugs. You can also compare consumption regardless of animal age-groups, when using ADDkg.

Benchmarking threshold signal levels (70 % of action level in DK and different in the NL) and action levels (yellow card level in DK and action level in NL) can be set at individual MS levels appropriate for that MS and political reduction policy. This is done in the NL (SDa data) and in DK (VetStat data) as follows:

Sows **Signal / Action threshold**	**Slaughter pigs** **Signal/ Action threshold**
DK >3,01 / DK > 4,3 **NL 10-22 / NL > 22**	**DK > 4,13 / DK > 5,9** **NL 10-13 / NL > 13**

When benchmarking is used one has to know the consumption in relation to number of animals at risk. As swine is divided into different age-groups one has to have a standard weight for an animal in the different age-group and use this when one is calculating ADD/per pig in an age-group. **Risk communication of signal and action levels and best practice results of management etc. can be given to farmers from their vets or through the internet.** In DK a green, yellow and red signalling system over the internet is used to give the farmer risk communication on his antibiotic level and the mortality in the age-groups as well (SundReg). The information is given to him directly when he enters the DVFA databases for other purposes and he can see if his herd is green=OK level, yellow=signal level or red=action level. When using data on the herd level ADD and standard weights of pigs in different age-groups have to be the same in all MS in order to compare between MS or within MS when benchmarking herds.

Main advantages of comparing and measuring usage:

- will result in a 10-50% decrease in usage, as seen in DK and NL,
- will enable comparison between MS when ADDkg is used
- will enable comparison between MS and between herds IF same standard animals, age-groups, SPC values and active compound only are used for ADD calculations
- will enable politicians to set reduction targets and signal and action threshold levels from data on ADD/pig/year from a fairly small sample of herds in MS
- will enable other farmers – on a voluntary basis - to measure their ADD/pig/year and benchmark themselves to the political action levels, when they know the ADD calculations and from their billing system know the amounts and type of antibiotics used and from their

sow or slaughter data can calculate the numbers of pigs at risk in the same time span- **a simple spread sheet calculation for ADD can do it for them.**

- This transfer of knowledge to farmers, vets and advisors will raise awareness to farmers and vets on their contribution to the antibiotic problem and how they can contribute to solve the problem. This ought to motivate them towards a reduced use.

Down sides:

Farmers must have computer access and be able to use a spread sheet or their vets must be able to.

Attention:

Attention should be given to conduct risk communication and discussions of solutions between vets and farmers in an organised manner for instance through stakeholders association meetings, courses etc.

Further testing should be done in economic benefits at farm level by changing management factors reducing antibiotic consumption by changing animal health and welfare and saving money and work hours in treatment of animals and vet visits. And this information should be given to farmers in order to motivate them to change management in their farm due to economics.

Topic: Specific alternatives to antibiotics

Solutions/possibilities

Existing/tested:

- **ZnO treatment as an supplement or alternative to antibiotics**

Pigs are treated with 2500 ppm ZnO in the first 14 days after weaning. Farmers think this reduced the antibiotics needed with 50-70 %, but they still use a lot of antibiotics at weaning, so maybe it is just a precautionary treatment with either antibiotics or ZnO !

Down sides:

An environmental issue as ZnO is a heavy methal. Also some concern, but not demonstrated, that there could be a link between ZnO and MRSA.

New

- **Resistance load and type on the herd level and its contribution to public health**

Maybe not an alternative to antibiotics, but research in which kind of treatment and which kind of administration route will develop the lowest or highest load of resistant bacteria within a herd. There are two research projects on the topic in DK: Mini-resist at CU-LIFE and Resist at DTU-Food. After all, the amounts of antibiotics used are not the most crucial issue in reducing public health concerns due to antibiotic usage, but the resistance the usage creates, is the crucial issue. And there might be a future where we are not measuring amounts used within a herd, but the resistance load and type the individual herd contributes with. By altering the farmer and vets treatments of the pigs, through information and awareness to the farmer and vet on better treatment possibilities and administration routes, thereby securing public health by a lower resistance load, but still giving effective treatment of the pigs, is the issue. An example could be a treatment with a high initial dosage of parenteral administered GI antibiotics, but a shorter treatment period.

Topic: General enhancement of animal health and welfare

Solutions/possibilities

New

- **Welfare index in swine herds describing, among else, the link between herd animal welfare and consumption of antibiotics**

A 4 year research project between several universities and the DVFA in DK is being conducted, where all kind of database data from DVFA´s veterinary datawarehouse (Cleveland Nielsen, 2011) is used including meat control data and supplying with herd data on the animal level plus resource level are being used to develop an index describing animal welfare. This index on the herd level can be compared with the ADD per pig on the herd level in order to describe associations between antibiotic usage and welfare of pigs. The project is politically driven due to concerns for animal welfare in pig herds when antibiotic use is being reduced due to the threshold values for antibiotic consumption in the yellow card system and in order to have an optimal control of both animal welfare and antibiotic consumption. The issue for the farmer is, that he can see how his is doing animal welfare wise and compared to his treatments.

References

Aarestrup FM, Seyfarth AM, Emborg HD, Pedersen K, Hendriksen RS, Bager F. Effect of abolishment of the use of antimicrobial agents for growth promotion on occurrence of antimicrobial resistance in fecal enterococci from food animals in Denmark. Antimicrob Agents Chemother. 2001;45(7):2054-9.

EFSA Panel on Biological Hazards (BIOHAZ). Scientific Opinion on the public health risks of bacterial strains producing extended-spectrum β-lactamases and/or AmpC β-lactamases in food and food-producing animals. EFSA Journal 2011; 9(8):2322 [95 pp.].

Stege H, Bager F, Jacobsen E, Thougaard A. VETSTAT-the Danish system for surveillance of the veterinary use of drugs for production animals. Prev Vet Med. 2003 Mar 20;57(3):105-15.

Jensen VF, Jacobsen E, Bager F. Veterinary antimicrobial-usage statistics based on standardized measures of dosage. Prev Vet Med. 2004 Jul 16;64(2-4):201-15. Review.

Cleveland Nielsen, A. Data warehouse for assessing animal health, welfare, risk management and – communication. Acta Vet Scand. 2011; 53(Suppl 1): S3.

Intestinal microbiota an health

Pedro Rubio

The existence of microbe free animals in nature is impossible as they must have a symbiotic association with microbes. Some years ago the holobiont concept was introduced to name the living being formed by the host and its microbiota.

The importance of the intestinal microbiota on the health is becoming more and more obvious. This fact is highlighted by the number of papers on this subject in PubMed that has suffered a huge increase, going from 496 in 2008 to 2494 in 2013.

The human being is the species in which the microbiota is best studied. The number of bacteria of the digestive microbiota in man is 100 times higher than the number of body cells and this bacterial microbiota has a number of genes 150 times higher than the human genes. Digestive microbiota has been named as the "forgotten organ" because it carries out a variety of functions which sustain health and, when disrupted, lead to disease. It is considered that the metabolic capacity of the digestive microbiota is similar or superior to that of the liver.

The intestinal microbiota is highly variable. In the human gut bacteria of between 500 and 1000 different species. The microbiota is also variable in relation to the time and the space that it occupies can be found. The microbiota of a lactating piglet is very different from that of a weaned or a fattening pig. There are also marked changes along the gastrointestinal tract. Both species and number of bacteria are significantly different from the stomach to the colon.

The intestinal microbiota has metabolic functions, such as the vitamins synthesis or the digestion of different feed components that are indigestible for the pig. The other important functions of the intestinal microbiota are the defense against pathogens and the stimulation of the development and maturity of the immune system.

Early life exposure to microbiota begins "in utero" and progresses gradually during the first weeks of life. In humans it is well known that this initial colonization largely determines the future of the immune response. Infants born by Caesarean section have a very different microbiota of infants born vaginally and this fact causes a deep impact in their immunological system. The microbial stimulus on intestinal mucosa specific receptors triggers off a series of events that are essential for the future immune response also in the piglet. The intestinal immune system also learns to distinguish between pathogens and symbiotic microbiota.

Once established, mature microbiota contributes to the health of pigs in several ways such as maintenance of the intestinal barrier, stimulating the secretion of IgA, producing short chain fatty acids and bacteriocins and competing for substrates and receptors.

Therefore the microbiota is of vital importance in the health of the pig. Many bacteria of the digestive microbiota have not been cultured so far, but the availability of DNA sequencing technologies and the reduction of their costs has enabled a great breakthrough over the last few years in the knowledge of the digestive microbiota and of its changes after different kinds of interventions.

The intestinal microbiota has a good resilience, but can change in a positive or a negative sense by different factors. The use, and especially the misuse, of antibiotics is the main origin of disturbances of intestinal microbiota and often leads to more severe disease.

Possibilities of intervention

It is possible to modify the microbiota in the right way in order to keep or recover the intestinal health so as to contribute to decrease or avoid the use of antibiotics.

There are specific diseases of the digestive tract in pig, as swine dysentery, but many of the digestive disorders at present affecting pig production are the so-called "dysbiosis", that has been defined as qualitative and quantitative changes in the intestinal flora, their metabolic activity and their local distribution. The colibacillosis and the different digestive infections by *Clostridium* spp. are dysbiosis.

It seems possible to treat or to prevent this dysbiosis restoring or maintaining the right equilibrium in the digestive microbiota. The main products used with this objective are **probiotics** and **prebiotics** and a combination of both (**symbiotics**). The "**parabiotic**" concept has been recently introduced to name the use of inactivated microbial cells or cell fractions to confer a health benefit to the host.

Probiotics are living microorganisms which, when administered in adequate amounts, provide a health benefits on the host. These health benefits are highly dependent on the bacterial strain and on the situation and the moment in which they are administered. The probiotic effects are attributed to the interaction of probiotics with other microorganisms (members of the microbiota or pathogens) or to the cross-talk of probiotics with host cells. LAB (lactic acid bacteria) are usually the main components of the probiotics.

Prebiotics are defined as components of the feed that are non-digestible by the host, that beneficially affect its health by selectively stimulating the growth and activity of beneficial of bacteria in the intestine, and symbiotics are a combination of a probiotic and a prebiotic with the aim of increasing the survival and activity of the probiotic "in vivo" as well as stimulating indigenous beneficial bacteria.

The knowledge on the effects of probiotics, prebiotics, synbiotics and parabiotics has increased and there are a numerous research papers on this subject, but the information concerning their impact on the health of the pig is still incomplete

It is important to increase the research on the efficiency of this products supported by the knowledge on their action mechanism. Genomic-based knowledge on the composition and functions of the gut microbiota as well as its disturbances allows for the selection of more specific products and to study their activity in deep at this moment.

The use of this types of products with a proven efficiency permits a reduction in the use of antibiotics in pig production

Vaccination contributes to responsible use of antibiotics in pig production

Dieter Schillinger

Introduction

We can anticipate on-going pressures for reducing antimicrobial use in pig production, even if there is no published risk assessment linking an increased risk of human clinical treatment failures with any specific antimicrobial use in food animals. However, if we assume that any reduction of antimicrobial use is desirable it seems logical to eliminate antimicrobial uses that are 'less necessary' or less justifiable in terms of benefiting animal health and welfare (P. Davis). The European Platform for the Responsible Use of Medicines in Animals (EPRUMA) defines responsible use as a key concept in ensuring appropriate use of antimicrobials which includes biosecurity, good housing, appropriate nutrition, regular monitoring of health and welfare, herd health plans, diagnosis and treatment under veterinary care, use of medicines according to instructions, and vaccination.

The Ana Rosbach report (EU Parliament Plenary 11.12.2012) underlines that to avoid massive over-use of antimicrobials, livestock farming, aquaculture and human medicine should focus on disease prevention. Also the European Commission's Action Plan against the rising threats from AMR covers seven areas of which one emphasizes preventing microbial infections and their spread - Action No 5 of the Road Map of the European Commission: Adoption of a proposal for an Animal Health Law, which will focus on prevention of diseases, reducing the use of antibiotics and replacing current animal health provisions based on disease control. The final proposal was adopted on May 6, 2013, and is currently in ordinary legislative procedure.

Biosecurity measures and vaccination programs are the main strategies to avoid infectious diseases and by doing so reducing antimicrobial consumption in pig production. MINAPIG has asked 111 pig health experts from 6 EU countries re the potential alternatives for antimicrobial use. The best average core was given for internal biosecurity and increased vaccination. Vaccinations are available for a number of bacterial and viral diseases that affect swine. But only for a few vaccines systematic research on the impact on antibiotic consumption has been carried on farm level.

Existing solutions underused by farmers which should be promoted

The Norwegian Atlantic salmon production is a great example for replacing antibiotics by vaccines. The introduction of the first injectable furunculosis vaccine in the early 1990's started the true revolution in the field of fish health management in the Norwegian Atlantic salmon production. This furunculosis vaccine was made multivalent in 1992, securing protection against three types of vibriosis in addition to furunculosis. More vaccine introductions followed. Vaccines enabled the disease-plagued industry to move from treatment with regular and wide spread use of antibiotics to prevention and protection through routine vaccination. Effective vaccines were probably the most important single factor in creating the possibility for the Norwegian aquaculture to grow the production but also to reduce its use of antibiotics by 99.8% per ton of trout and salmon produced, compared to the 1987 level.

Obviously, using vaccines to prevent disease rather than antibiotics is an easy way to reduce antibiotic usage. Here a first review on published data to what extent vaccination can reduce antibiotic usage in pig production.

funded by European Commission

Buntgaard, H., et al. (2012)

“In a study conducted in Denmark on 20 farms, those using a live ***Laswonia intracellularis*** **vaccine** used less antibiotics than those that did not: 11.4 ADD per 100 weaned pigs versus 14.8.”

Nerem, J. (2009)

“Use of 10 grams of dietary tylosin phosphate per pig was avoided by using ***Lawsonia intracellularis*** **vaccine** for prevention of proliferative enteropathy (PE). This study demonstrated that pork producers may change from routine use of finishing dietary antimicrobials to prevention of PE by vaccination without sacrificing performance. In addition, they may achieve an economic advantage.”

Bak, H. and P.H. Rathkjen (2009)

“The pigs were included batch-wise in the study with every second batch being vaccinated against ***Lawsonia intracellularis***. In the vaccinated batches, the consumption of oxytetracycline to treat PE was reduced by 79%, with a significant lower number of pigs being treated.“

Buntgaard, H. et al. (2013)

“The retrospective analysis demonstrates that the use of one dose ***PCV2*** **vaccine** at the time of weaning can control PCVD, improve performance, reduce antibiotic use and improve animal welfare. - Overall prevention of disease through vaccination addresses the environmental, social and economic requirements of modern pig farming and hence can be seen as a crucial element for a sustainable pork production.”

Pejsak, Z. et al. (2010)

“In this farm acutely affected with PMWS, the efficacy of ***PCV2 vaccination*** was confirmed. The three vaccination programs gave good improvement in terms of mortality rates, growth, feed efficiency, number of antibiotic treatments.”

Areas which need exploration

Autogenous vaccines are manufactured from the specific pathogenic bacteria isolated from a diseased pig. They are usually made under a licence for use only on that farm. They can be useful when serious disease outbreaks occur and standard commercial vaccines are not available. No information is available for the effects of autogenous vaccines on antibiotic consumption.

The global animal health vaccines market is in its growth phase. The factors responsible for the growth of the market include increasing incidences of zoonotic diseases in humans, growing prevalence of animal diseases and increasing investments by leading players and the search of alternatives for antibiotic treatment. Another factor driving the growth in this area is the continous innovation which lead to the launch of new products with the potential to reduce further the use of antibiotics in pig production. Newly launched vaccines should immediately be tested to measure their potential to reduce antibiotic consumption.

Today, proof of concept that vaccination reduces antibiotic consumption is available only for two diseases, PCV2 and Ileitis (as far as the author knows). Studies, demonstrating the effectiveness of replacing antibiotics by vaccines need to be carried out for other important pig diseases as well. These studies need to include an economic evaluation in order to have an additional argument for farmers to switch from antibiotics to vaccines.

Hindrances to replacing antibiotic treatments by vaccination:

- Vaccines are effective only against a specific disease (antibiotics have a wider efficacy spectrum).
- The creation of an effective vaccination programme for a farm needs a trustful and professional cooperation between vet and farmer.
- The choice of the right vaccine is based on continuous diagnostic measurements (cost).
- Farmers are trusting the routine use of antibiotics over many production cycles. Difficult to change this behaviour.
- Cost for vaccination programmes may be higher than routine use of antibiotics.
- Etc.

References

Bak, H. and Rathkjen, P.H. (2009): Reduced use of antimicrobials after vaccination of pigs against porcine proliferative enteropathy in a Danish SPF herd. Acta Veterinaria Scandinavica 51:1

Bundgaard, H., et al. (2012): How to reduce antimicrobial use in pig production. Proc. IPVS. Vol 1, 200

Bundgaard, H., et al. (2013): Vaccination significantly reduces use of antibiotics. PigProgress News, knowledge & career

Davies, P. (2013): In-feed antibiotics: some of the issues. The Pig Site; 14.11.2013

European Commission: Action Plan against antimicrobial resistance. 17.11.2011

European Commission: AMR Road Map

European Parliament (December 2012): The microbial challenge- rising threats from antimicrobial resistance

EC (2011) European Commission: Communication from the Commission to the European Parliament and the Council – Action plan against the rising threats from antimicrobial resistance

European Platform for the Responsible Use of Medicines in Animals: www.epruma.eu

MINAPIG (2013): Potential alternatives to antimicrobials in pig production based on perceived effectiveness, feasibility and return on investment. Poster, Safepork;

www.minapig.eu

Nerem, J. (2009): *Lawsonia intracellularis* vaccination as an alternative to dietary antimicrobial medication in finishing swine. Safe pork 2009, Québec, Canada

Pejsak, Z., et al. (2010): Efficacy of different protocols of vaccination against procine circoviurs type 2 (PCV2) in a farm affected by postweaning multisystemic wasting syndrome (PMWS). Comparative Immunology, Microbiology and Infectious Diseases, 33, e1-e5

Mini-paper on learning from herds with low antimicrobial consumption

Anne Wingstrand, senior researcher, DVM, Ph.D.

Introduction

The antimicrobial (AM) consumption in pig herds varies considerably between as well as within herd types. In a Danish study [1] from 2007-2008 (i.e. before the implementation of "yellow card") of the AM prescribed for slaughter pigs in conventional indoor herds, conventional herds with outdoor access for slaughter pigs (="free range") and organic herds, the mean number of doses for slaughter pigs in both conventional herd types was approx. 10 times the number of doses prescribed for organic herds. The difference in AM consumption between herd types even counted for herds of same size (i.e. annual slaughter betw. 2000 and 5000 pigs). A significant variation in prescribed AM for slaughter pigs, typically between 0 and 4 doses per slaughter pig produced, was also observed within each herd type (figure 1).

These huge differences in the registered herd consumption of AM for slaughter pigs raise the question about which factors, habits or legislation/rules that enables/encourage some farmers and veterinarians to keep the AM consumption at a low level while others don't. Identification of these factors may lead to useful and efficient measures which could be applied to herds in general or high-user herds specifically.

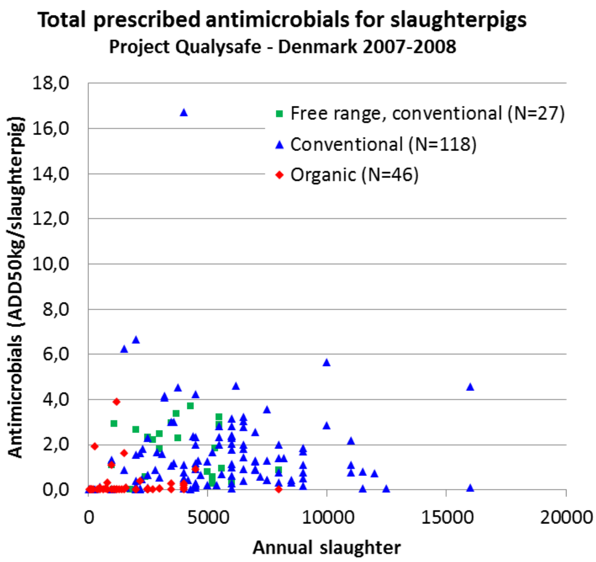

Figure 1. Total prescribed antimicrobials for slaughter pigs (doses per pig produced in each herd) in conventional (blue), free-range conventional (green) and organic pig herds (red) depending on herd size. Pers. Comm. A. Wingstrand, National Food Institute, Technical University of Denmark.

A questionnaire study revealed several differences between the 3 herd types including housing, management, feeding and reported diseases, and significant differences between legislation/rules for AM prescription and the use and consequences of AM use were identified. Although a causal association was not demonstrated, the herd characteristics which were similar for conventional and free range conventional herds (both with high AM consumption) but differing from organic herds (low consumption) could be considered factors potentially leading directly or indirectly to high consumption of AM in the herd.

Examples of such factors were [2]:

- Large annual slaughter, No sows, Any purchase of weaners/growers, Smaller area per pig indoor, High wheat/barley ratio in feed grains, No roughage fed to weaners, growers and finishers, Low weaning age
- Owner reporting existence of: mycoplasma pneumonia, actinobacillus pleuropneumoniae and gastric ulcers in the herd
- Herd Advisory Contract with the veterinarian (allowing for prescription of AM for expected diseases the following month)
- Owner allowed to initiate AM treatment
- No restrictions in number of AM treatments per pig

Solution/possibilities/downsides

- **Monitoring** consumption of AM in the herds is a prerequisite for identification of low-user herds to learn from/study. (*New* in most countries). From Danish and Dutch experiences the mere launching of coming monitoring and benchmarking led to a fast and marked drop in consumption, indicating that, besides from treatment of diseases, **habits and routines** are part of the difference in AM consumption in herds.
- **Identification of risk factors** for high consumption (infections, management, feeding, physical herd features, habits, legislation/rules (or missing), comparing low(organic) and high consumption herds and intervention studies. The research should include **economical** aspects of means to reduce AM consumption ad well as the efficacy. Well suited for research (*New*), but may also be identified from:
- **Erfa-groups** for farmers, veterinarians and agri-consultants (*Underused*) is generally considered a trustworthy forum for knowledge exchange. In DK only few vets and consultants are involved in organic farming, and sharing their experience would be important, as veterinarians may **hesitate** to refrain from prescribing AM for metaphylactic use (farmers expectations, animal welfare) without an alternative solution and colleagues experience as support. Erfa groups exist but **bringing together persons related to high/low consumption farms and organic farms** may broaden the view on new/alternative solutions. It seems important to focus on low consuming herds in general and not only on organic herds as some **resistance** otherwise may occur. Erfa groups will also be suitable for transfer/dissemination of knowledge from research to herds.
- The low AM consumption in some herds has led to **concerns** about **animal welfare** aspects of low AM consumption. It must be ensured, that sick animals are not left suffering due to lack of treatment (may alternatively be euthanized). Suitable for research (*New*) and possible subject for public control (*stade of development dep. on MS*).

References

DANMAP 2009. 2010. Uses of antimicrobial agents and occurrence of antimicrobial resistance in bacteria from food animals, foods and humans in Denmark, p 38-39. ISSN 1600-2032

Karakteristik af danske slagtesvinebesætninger 2007-2008. Økologisk, frilands- og konventionel produktion. (Characteristics of Danish slaughter pig herds 2007-2008. Organic, free-range and conventional production.) Report, National Food Institute, Technical University of Denmark, 2011. (In Danish with English summary on main differences between the three herd types).

EIP focus group on animal husbandry (reduction of anti-biotic use in the pig sector)

Rosanna Wregor

Existing/tested solutions	Information and Education

Reward and Sanction Systems e.g. Yellow Card System, Traffic Light System
Benchmarking e.g. Vetstat

Partly developed concepts	Experience Sharing (farmer self-help groups, Best Practice Manuals)

EU Surveillance Framework
Treatment Formularies / Guidelines
On-farm advice (general and for high users)
Use of good examples (low users, e.g. specific countries, organic producers)
Structured Educational Programmes and Material
Influencing Skills of Veterinarians
Health Monitoring Systems / Precision Livestock Farming
Facilitation of systems to treat sub-populations and individuals

Possible new solutions / research needed	Explore drivers for prescribing habits

Explore differences in usage between MS
Address concerns re de-coupling of prescribing and dispensing
Cost-benefit analysis for end user / consequence assessments
Taxing/pricing strategies
On farm target pathogen sensitivity testing
Science re. the impact of disease prevention

Introduction

Notable variation in veterinary antimicrobial usage between Member States (MS) exists (1). These variations may be due to a variety of factors, including differences in prescribing behaviour, distribution of animal species, differences in productions systems, disease profiles and the availability and price of veterinary antimicrobials (2). As a swine veterinarian with experience from a range of MS, these differences are fascinating and frustrating – and felt to be largely reflecting different stages of awareness and hence attitudes to the concept of antimicrobial resistance; impacting behaviour when it comes to antimicrobial usage.

A plethora of information on basic principles for change of behaviour/practices exists, particularly in the business sector, and three of these principles and how they could assist a move towards prudent usage will be discussed below.

Solutions/possibilities

Creating a 'Burning Platform' For any change in behaviour to take place it is imperative that those who will be affected comprehend the necessity for change. In business this is often done by explaining why change must happen and by creating a sense of urgency (3).

Clear vision and roadmap Equally important as knowing why change is necessary is to have an understanding of what we are trying to change into and how we will do so (3).

Rewards and Sanctions Attitudes do often, but not always, drive behaviour. One good example of when attitudes drive behaviour is when you stand to lose or gain something by the issue (4). For change to happen it is essential to change the 'reward system' – it must 'hurt' to stick with the old ways and give a pay off when successfully changing i.e. rewards and sanctions must be put in place (5).

Existing solutions

Attitudes towards antimicrobial usage can be influenced by information and education (6).

There has been significant media focus on antimicrobial resistance, particularly following the G8 summit where the Chief Medical officer described is as 'a catastrophic threat' – and by doing so creating a 'Burning Platform'. Other examples include the European Antibiotic Awareness Day and the range of activities and resources which follows the event; targeting both medical and veterinary use as well as the general public. For example, in the UK the British Veterinary Association produced guidance notes and posters for veterinarians and owners and the University of Liverpool arranged a stakeholder meeting for the veterinary profession to mark the event (7).

Education can assist further in creating an understanding of the need for change. Mandatory training in the use of medicines for all members of staff who administer medicines to food producing animals is implemented in e.g. Denmark and covers the subject of antimicrobial resistance (8).

Monitoring of antimicrobial use at the level of the individual herd and the individual prescriber as is done in the Vetstat programme (9) allows for benchmarking and as such helps to create a vision and roadmap, in that producers and veterinarians can compare themselves with the average for the whole country and also see changes in usage/prescription habits over time.

The Danish Yellow Card System, based on Vetstat, is an example of the concept of rewards and sanctions. The Netherlands use a similar 'traffic light system' (6).

Concepts which are partly developed

Monitoring of antimicrobial resistance and usage is essential for risk management, but as yet does not allow for comparison between MS. The European Food Safety Authority (EFSA) and the European Medicines Agency (EMA) has taken steps to establish a joint European Surveillance framework (2). This needs to be further developed so that producers and veterinarians can compare themselves to an EU standard and by doing so understanding where they are on the 'roadmap'.

Several approaches to raise awareness of the need for change and examples of how it is possible to do so are already in place but many of these needs to be further structured and formalised:

A number of treatment formularies and guidelines on prudent usage exist, and whereas these may serve a certain purpose in raising awareness, it is difficult to establish the specific effects of such guidelines (10). The main benefit of such guidelines may well lay in the collaboration between stakeholders with a diverging perspective, and if this is the case, such guidelines needs to be an 'active' document - continuously evaluated and discussed.

Use of 'good examples' i.e. low users could facilitate creating the vision/roadmap. Countries such as Denmark and Netherlands have shown that antimicrobial usage can be reduced significantly, and this could serve as a useful example of what and how it is possible to do so (2). Learning from organic production and other low usage producers has also been suggested (eip-agri focus group Animal Husbandry, Breakout Group 2).

Pig industry organisations such as British Pig Executive (BPEX) and the Danish Pig Research Centre (VSP), has developed several general on-farms tools such as videos and manuals of 'Best Management Practices' (11, 12). These manuals are available on-line, but not widely promoted. VSP has further developed a guideline specifically on Good Antibiotic Practice (13) which is published in Danish, English and Russian to target as many stockmen as possible – this guideline currently focuses only on management practices for prevention of diarrhoea in weaners and finishers and as such needs to be further developed and also disseminated.

Studies have shown that farm factors associated with the use of antibiotics include; farm systems, number of pigs and population density in the region, and as these factors are easy to collect; they can be used to create farm specific advice (14).

Farmer experience-sharing groups works well in countries where there is a tradition for openness and of sharing experiences, and a model to adapt these to suit countries where there is not such an 'open' culture should be considered.

Educational programmes can help raise awareness and promote good practice (6).The use of best practices/ good examples as discussed above needs to be structured and supervised and this could be facilitated by establishing a co-ordinating body consisting of relevant stakeholders.

The primary veterinarian contracted to a pig farm has a responsibility to educate the end user in the prudent usage of antibiotics as part of any herd health plan (15), and is also required to do so e.g. by some farm quality assurance schemes (16). Vets needs to improve their influencing skills to guide their clients towards change (17) and training to support the veterinarians in this conflicting role could be beneficial.

Monitoring of antimicrobial usage at the level of the individual herd and the individual prescriber allows for targeted advice to high-end-users (10).

Ongoing Precision Livestock Farming projects needs to be further developed with particular focus on monitoring systems which can be used as early indicators of when treatment is necessary e.g. early detection of respiratory diseases via sound monitoring (SoundTalks: part of the EU funded All-Smart-Pigs, 18). Systems like this can assist in the use of antimicrobials on an 'as and when necessary' basis as opposed to the continuous (prophylactic) use.

Similarly, solutions which can assist in treatment of sub-populations, e.g. treatment of pens, should be facilitated (for example by funding such options on farm and support of availability of e.g. water-soluble antimicrobials and wet feed administration systems such as MedLiq, 19). Innovative solutions for treatment of individuals should also be investigated (for example, supporting development of antimicrobials which can be administered subcutaneously by high pressure guns and enhancement of existing training systems such as Individual Pig Care by Zoetis, 20).

All the above options to treat selectively would reduce cost of treatment to the producer and hence be a 'reward' / 'driver' to change behaviour.

Areas to explore to find new solutions and research needed

Private veterinarians in most countries earn their income by selling antimicrobials directly to producers. It is speculated that this could provide an economic incentive for over-prescription (6).

The proportion of income for the practicing veterinary surgeon generated by drug sales is not readily accessible in the published literature, but the experience from Denmark indicates that a substantial economic incentive for prescribing antimicrobials was present until it was prohibited for veterinarians to earn a profit on drug sales. Danish legislation is now designed to ensure that distribution of veterinary medicines takes place through authorised pharmacies. Since 1994 Danish veterinarians have no longer the right to dispense, and the profit from direct sales of medicine is fixed at a very low level. The enactment of this legislation resulted in an immediate reduction in the total volume of antimicrobial drugs prescribed by 40% (21). It would be reasonable to assume that this reduction was because of the removed economic incentive.

Spanish veterinarians, do not however, sell antibiotics and despite this the veterinary antimicrobial consumption in food producing animals in Spain is still one of the highest as measured by sales in mg/PCU (1). Research is needed to explore the pros and cons of decoupling veterinarians' ability to dispense antimicrobials. There are concerns that unintended consequences such as higher cost and inconvenience for customers and poorer care for animals could ultimately result in poorer animal welfare (22). These concerns need to be addressed.

The Heads of Medicines Agency and the Federation of Veterinarians in Europe undertook a survey looking at factors influencing antibiotic prescription habits amongst veterinarians in Europe (23). No single information source was found to be universally critical – training, published literature and own experience were considered amongst the most important. In terms of factors which directly influenced prescribing habits, sensitivity testing, own experience and the risk of antibiotic resistance developing i.e. resistance in target pathogens were considered the most important factors. The least important factors were considered to be owner demand, culture, profit margin and advertising.

Further exploration into drivers of antibiotic prescribing habits is clearly necessary. Similarly, the differences in antimicrobial usage between MS needs to be investigated, speculative assumptions as discussed in the introduction makes it difficult to justify such big differences and it is easy to jump to the conclusion that this is indicative of irrational usage(2).

In line with the survey above, improved sensitivity testing and services (speed and cost) also needs to be developed. Target pathogen surveillance could help to build the 'burning platform' by showing the producer what relevance it has to him.

Research into disease prevention and its role in reducing antimicrobial usage is sparse and scientific studies addressing this specific point are needed (10) to help producers understanding of how the change can actually be achieved.

The history of antimicrobial use in animals goes back to post-war time, when there was a need to produce cheap food (2), and today this demand is driven by a growing world population (6). Intensive food animal production increase the chance of transmission of disease and the impact of changing production systems on the extent of antimicrobial usage is not well studied (6). Consequence Assessments/ Establishment of cost-benefit at farm level are necessary to drive change in behaviour (eip-agri Animal Husbandry focus group, breakout group 2). The little data which is available e.g. from Denmark and Netherlands, indicates that it is possible to reduce usage without significant losses in productivity (2,6) but this needs to be further explored.

Several human studies have shown the link between expenses and prescription of certain drugs. It is safe to assume that the same would apply to veterinary medicine (10). A differentiated pricing strategy has recently been introduced in Denmark, favouring the use of vaccines and disfavouring use of critically important antimicrobials (24). This is another example of a reward/sanction strategy which can aid change in behaviour. More scientific studies addressing the effects of pricing/taxation strategies are needed (10).

References

(1) EUROPEAN MEDICINES AGENCY (EMA) (2013). Sales of veterinary antimicrobial agents in 25 EU/EEA countries in 2011. Third ESVAC Report. www.ema.europa.eu/docs/en_GB/document_library/Report/2013/10/WC500152311.pdf. Accessed December 24, 2013

(2) GUARDABASSI, L. (2013). Sixty years of antimicrobial use in animals: what is next? *Veterinary Record* December 21/28, 2013, Vol 173, No 24, pp599 – 603

(3) KOTTER, J.P., and COHEN D.S. (2002). The Heart of Change. Harvard Business School Press. ISBN 1-57851-254-9

(4) CHERRY, K. (2013). How Attitudes Form, Change and Shape our Behaviour. http://psychology.about.com/od/socialpsychology/a/attitudes.htm Accessed December 24, 2013

(5) PRITCHET P. and POUND R . (2008). High-velocity Culture Change. ISBN 978-0-944002-13-1, p.12

(6) STÄRK, K. (2013). Brief overview of strategies to reduce antimicrobial usage in pig production. Starting Paper for eip-agri Focus Group: Animal Husbandry (reduction of anti-biotic use in the pig sector). http://ec.europa.eu/agriculture/eip/focus-groups/animal-husbandry/starting_paper_en.pdf Accessed December 24, 2013

(7) ANON (2013). Antimicrobial Resistance: resources for vets and owners. *Veterinary Record* November 16, 2013, Vol 173, No 19, p 461, doi:10.1136/vr.f6824

(8) DANISH VETERINARY AND FOOD ADMINISTRATION (2013). Medicinhåndteringskursus. http://www.foedevarestyrelsen.dk/Dyr/Laegemidler_til_dyr/Medicinhaandteringskursus/Sider/default.aspx Accessed December 26, 2013

(9) STEGE, H., BAGER, F., JACOBSEN, E., and THOUGAARD, A. (2003) VETSTAT-the Danish system for surveillance of the veterinary use of drugs for production animals. *Prev Vet Med.* 2003 Mar 20;57(3):105-15.

(10) WEGENER, H. (2012) Antibiotic resistance – linking human and animal health. In Improving Food Safety Through a One Health Approach: Workshop Summary. Institute of Medicine (US). National Academic Press. http://www.ncbi.nlm.nih.gov/books/NBK114485/ Accessed December 27 2013

(11) BPEX (2012) Pioneering Practical Pig App from BPEX 26 July 2013. http://www.bpex.org.uk/articles/303085/Pioneering_Practical_Pig_App_From_BPEX__26_July_2013.aspx Accessed December 27 2013

(12) VSP (2013) Til Staldgangen 2013. http://vsp.lf.dk/Viden/Til%20staldgangen.aspx Accessed December 27 2013

(13) VSP (2013) Manual om god antibiotika praksis. http://vsp.lf.dk/Viden/Til%20staldgangen/Manualer/antibiotikapraksis.aspx Accessed December 27 2013

(14) FELS-KLERX van der H.J., PUISTER-JANSEN, E.D., ASSELT van A. D. and BURGERS L.G.E. (2010). Farm factors associated with the use of antibiotics in pig production, *J Anim Sci* 2011, 89: 1922 – 1929. doi: 10.2527/jas.2010-3046

(15) HEALY, D. (2013). Responsible and Prudent Use of Antibiotics on Irish Pig Farms. http://www.thepigsite.com/articles/4534/responsible-and-prudent-use-of-antibiotics-on-irish-pig-farms Accessed December 27 2013

(16) Red Tractor Assurance (2013). Red Tractor Pigs Scheme – QVR (updated March 2013). http://assurance.redtractor.org.uk/resources/000/577/236/standard_20117151729321.pdf Accessed December 27 2013

(17) ANON (2013) Assuring the welfare of food animals. *Veterinary Record* 2013, Vol 173, No 23, pp. 568 – 569

(18) ALL SMART PIGS (2013) Sound Talks http://allsmartpigs.com/index.php/about-us-2 Accessed 27 December 2013

(19) MEDLIQ.DK (no year). http://www.medliq.dk/index.html Accessed December 27, 2013

(20) ZOETIS (2013). Individual Pig Care. https://online.zoetis.com/US/EN/Solutions/Pages/IndividualPigCare%E2%80%93It%E2%80%99stheRightThingtoDo%C2%AE.aspx Accessed December 29, 2013

(21) CLEVELAND, A., AARESTRUP, F. and MYGIND J. (2007). Risk management of antimicrobial use and resistance from food-producing animals in Denmark. A contribition to the joint FAO/WHO/OIE Expert Meeting on Critically Important Antimicrobials, Rome, Italy, 17-21 September 2007. Available at http://www.uk.foedevarestyrelsen.dk/NR/rdonlyres/57B755D0-4AF5-4132-9E5E-BD924C8242B/0/Risk_management_antimicrobial_use_andresistance_Denmark_E.pdf , last accessed October 15th 2010

(22) (ANON) (2013). Prescribing, dispensing and welfare. *Veterinary Record* 2013, Vol 173, p.360, doi:10.1136/vr.f6254

(23) BRIYNE DE, N., ATKINSON, J., POKLUDOVA, L., BORRIELLO, S.P. and PRICE S. (2013). Factors influencing antibiotic prescribing habits and use of sensitivity testing amongst veterinarians in Europe. *Veterinary Record* 2013 Nov 16;173(19):475. doi: 10.1136/vr.101454. Epub 2013 Sep 25

(24) DANISH VETERINARY AND FOOD ADMINISTRATION (2013). Nye afgifter på antibiotika til produktionsdyr. 2013. http://www.foedevarestyrelsen.dk/Nyheder/Nyheder/Arkiv_2013/Sider/Nye-afgifter-på-antibiotika-til-produktionsdyr.aspx Accessed December 27 2013