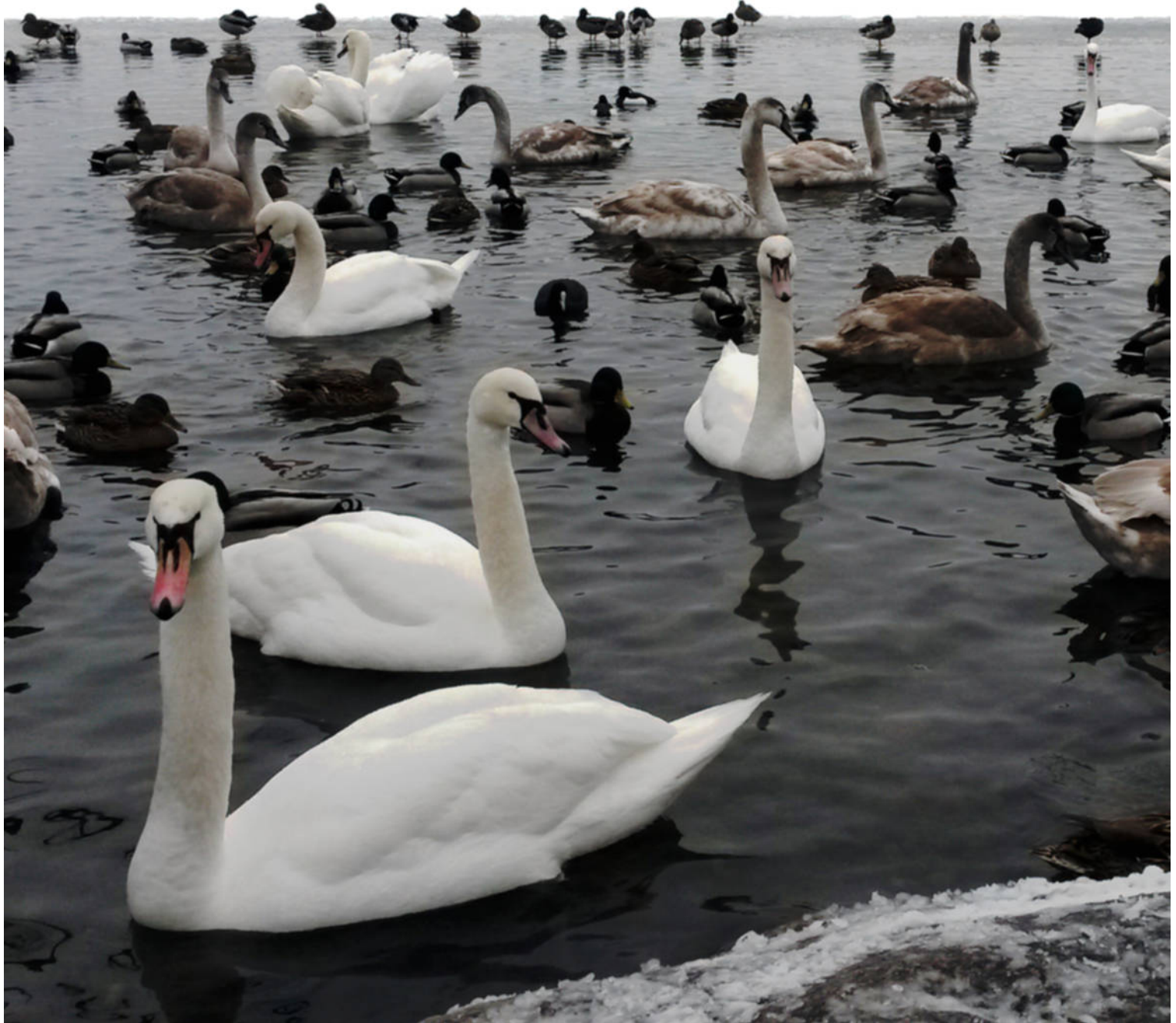


SURVEILLANCE OF INFECTIOUS DISEASES IN ANIMALS AND HUMANS IN SWEDEN 2016



Editors: Ann Lindberg, Elina Lahti, Thomas Rosendal

Department of Disease Control and Epidemiology, National Veterinary Institute (SVA), SE-751 89 Uppsala, Sweden.

Authors: Anton Andreasson, Charlotte Axén, Björn Bengtsson, Mia Brytting, Erika Chenais, Arianna Comin, Helena Eriksson, Linda Ernholm, Gunilla Hallgren, Gete Hestvik, Marika Hjertqvist, Mia Holmberg, Cecilia Hultén, Helena Höök, Jerker Jonsson, Elina Lahti, Ann Lindberg, Mats Lindblad, Ylva Lindgren, Anna Lundén, Emma Löf, Margareta Löfdahl, Maria Nöremark, Anna Ohlson, Faruk Otman, Karin Persson-Waller, Moa Rehn, Thomas Rosendal, Christoffer Sjölund, Karl Ståhl, Lena Sundqvist, Kaisa Sörén, Magnus Thelander, Kerstin de Verdier, Catrin Vesterlund-Carlson, Helene Wahlström, Anders Wallensten, Per Wallgren, Stefan Widgren, Elsie Ydring, Siamak Zohari, Erik Ågren

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Layout: For the third year, the production of this report was accomplished using a primarily open-source toolset to build a report generating process. This allowed the source text, produced by authors, to be edited independently of the template for the layout which can be modified and reused for future reports. Specifically, the chapter texts were authored in Microsoft Word and then converted using pandoc to the LaTeX typesetting language. All figures and maps were produced using R software for statistical computing.

Development for 2016 was focused on formalising the report generation tool in an R-package, which has streamlined the report building and integrates quality control into the process. This will also allow the workflow to be used in other projects in the future. Also this year, typesetting has been further separated from the author text content in order to make it possible for authors and the editor to make changes without substantial disruption to the layout of the report. Finally, the author inputs this year were performed in the online editor Office365 which improved the absorption of text changes into the final report.

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Photo: Karin Bernodt

Introduction

Surveillance of infectious diseases in animals and humans 2016 is the annual report on surveillance activities carried out in Sweden during the year, and their output. The report covers surveillance for animal diseases and zoonotic agents in humans, food, feed and animals, carried out and compiled by agencies with surveillance mandates along the entire food chain, from stable to table.

The information generated by animal disease surveillance is of key importance for the declaration of the good health and welfare status of Swedish animals. Some benefits of surveillance activities are inherent, such as the prevention of animal disease and promotion of public health. However, a lot of surveillance activities are in place primarily to ensure safe trade and movement of animals, thereby facilitating trade and giving access to foreign markets. This is also where the major costs appear in case of outbreaks of regulated diseases; by the restrictions put in place to maintain trust between trading partners. To reinstate a favourable status it is necessary to provide evidence in the form of high quality surveillance data that disease is once again absent from the country, region or sector, or at least under control.

Surveillance activities are similar to insurance in that the return on investment only become visible when something happens. They are costly, as they require resources for planning and design as well as for implementation, including: organisation of the collection of samples or other types of data from different groups in a representative way; to identify and use accurate and timely diagnostics; and finally, to analyse the data and communicate it to relevant stakeholders for decision making.

Consequently, investments in surveillance may seem difficult to justify, in particular when the disease burden or perceived threat from exotic disease is low. This is sometimes referred to as the “good health status paradox”, which means that it becomes challenging to motivate investments to maintain a favourable disease situation, e.g. surveillance aimed at early detection, simply because the disease is no longer present. To mitigate the risk of deteriorating the national surveillance capacity, and instead identify long-term goals for the existing system, a national surveillance plan with well-defined quality goals has been developed for Sweden. The plan provides guidance for prioritisation, both of hazards for which surveillance should be conducted, and for activities related to maintenance and development of surveillance components and programmes. The implementation of the national surveillance plan has

been successive; it was first available in 2015, then formally adopted in 2017 and will continue to be implemented during 2018.

Surveillance initiatives must be regularly evaluated and allowed to evolve to incorporate new diagnostic methods and new knowledge of the disease. Over the past years, a number of interesting projects within this field have been running at SVA where the findings are likely to contribute to more efficient surveillance in the future. For diseases that are highly regulated, such as transmissible spongiform encephalopathies (TSE), the recognition in 2016 of Sweden as having a negligible risk of classical scrapie means that requirements to avoid introduction of disease can remain, and export facilitated, although annual sampling will be decreased. This achievement is also largely dependent on the previous years’ surveillance efforts and evidence provided on the Swedish animal health situation.

Another TSE, Chronic Wasting Disease (CWD), appeared for the first time in Europe in early 2016, in Norway. This finding has resulted in substantial surveillance and control activities in Norway as well as risk assessments for the European context, with decisions on surveillance requirements still pending. This is just one of several emerging diseases where wildlife populations are in the spotlight. Other examples where wildlife surveillance is of great importance for the early warning and protection of domestic populations are African Swine Fever (ASF) and highly pathogenic avian influenza (HPAI).

The outbreak of HPAI H5N8 in 2016 affected wild bird populations and commercial poultry flocks across most of the European continent, including Sweden. The wild bird surveillance conducted for HPAI was instrumental in understanding the nature of the epidemic, both in terms of predicting changes in risk of introduction in the beginning of the outbreak, to supporting decisions and communication with regard to downscaling control measures by the end of it.

In general, good knowledge and awareness in the field, good collaboration with representatives of different sectors along with a well-structured passive surveillance system are vital to prevent the introduction and establishment of serious infectious transboundary diseases from outside of Sweden, and in the case of introduction, have means for early detection and action.

Livestock populations and trade in live animals

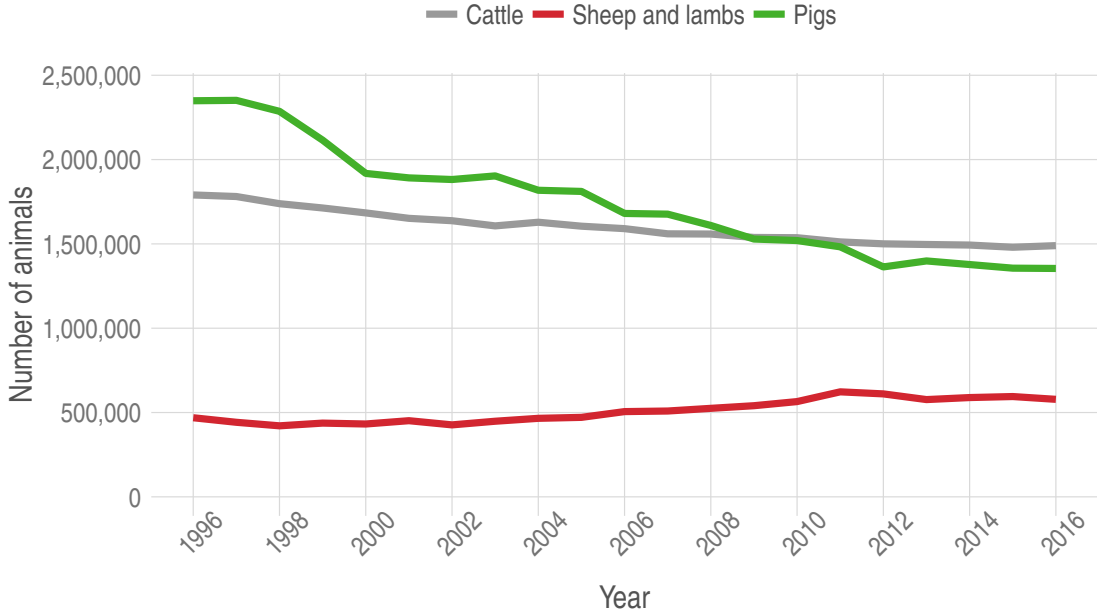


Figure 1: Number of Swedish livestock 1996-2016.

Demographic data show that most farms are located in the southern and central parts of Sweden and meat and milk are the major lines of production. In the northern part, farms are mainly small. During the last decade the number of holdings with livestock has decreased, but the average size of those remaining have increased.

Figures 1, 2, 3 and 4 give an overview of the livestock population in Sweden in 2016. The statistics for aquaculture covers 2015.

CATTLE

There are approximately 17,000 holdings with a total number of 1,488,900 cattle (dairy cows, cows for calf production, heifers, bulls, steers and calves younger than one year) in Sweden (Figure 2). The average herd size is largest in the county of Halland and Skåne and smallest in the county of Jämtland and Västerbotten.

The number of dairy cows has decreased over a long period of time period. In June 2016, there were 330,800 dairy cows in 3,900 holdings with an average of 85 cows per herd. The number of cows for calf production was 193,700 in June 2016 with an

average herd size of 19 cows.

In total, approximately 394,000 adult cattle and 16,000 calves were slaughtered during 2016.

PIGS

The total number of pigs was 1,354,300 (Figure 3) in June 2016. The total number of pigs has decreased over a long period of time, but during the last year the decrease has been less significant.

About 2,526,000 pigs were slaughtered during 2016.

SHEEP

In 2016, there were 8,669 sheep holdings with a total of 281,327 ewes and rams (Figure 4). Sheep holdings in Sweden are usually small-scale enterprises with an average herd size of 32 adult sheep. During 2016, approximately 251,000 sheep were slaughtered of which 218,000 were lambs.

GOATS

The reported number of goats in December 2016 were 16,031. They were kept on 450 different holdings.

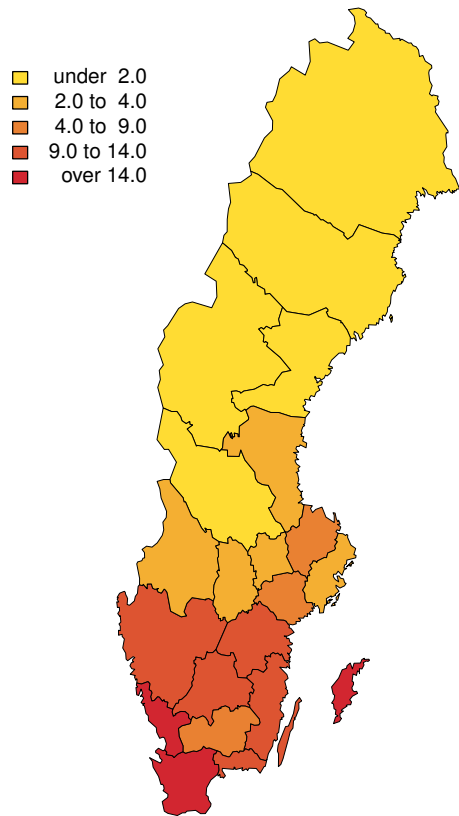


Figure 2: Number of cattle per km² in 21 Swedish counties as of June 2016.

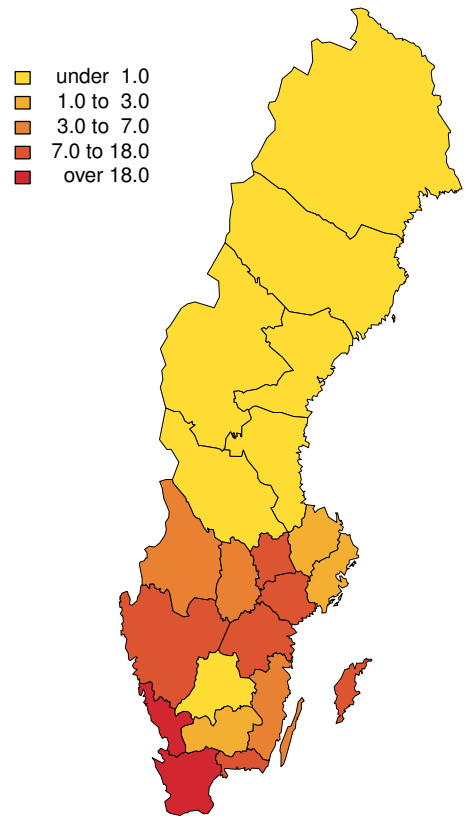


Figure 3: Number of pigs per km² in 21 Swedish counties as of June 2016.

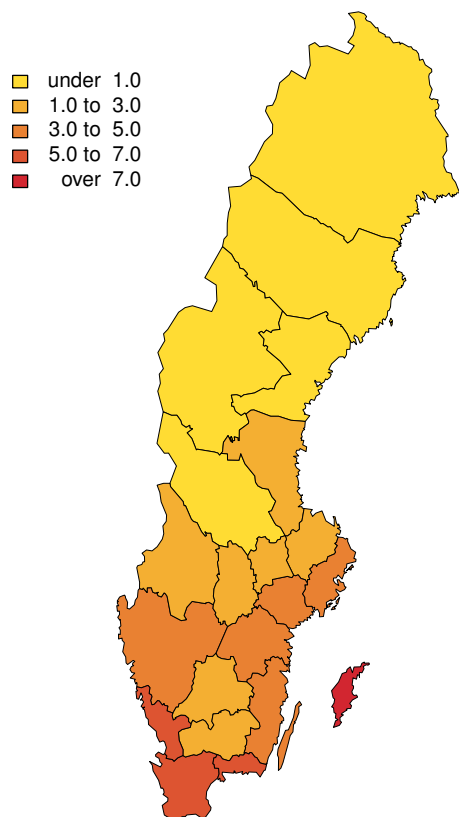


Figure 4: Number of sheep per km² in 21 Swedish counties as of June 2016.

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POULTRY

The number of fowl has increased continuously the last two decades. In 2016, there were 8.2 million hens (chicken not included) in 2,900 commercial holdings, which means that the population increased but the number of holdings stayed the same compared to 2015.

Eggs delivered to wholesalers amounted to 120.7 million kilos during 2016.

The number of holdings with broiler production in June 2016 was 262 and about 101 million chickens were sent for slaughter during the year. During 2016, 527,000 turkeys were slaughtered.

The production of geese and ducks is very small. In 2016, 15,649 geese and 2,806 ducks and no guineafowl were slaughtered.

FISH AND SHELLFISH

Rainbow trout are the most frequently farmed fish followed by char, salmon and brown trout; salmon and brown trout are mainly for restocking of feral populations. The shellfish production is dominated by cultivated blue mussels, 1,525 tonnes.

In 2015, there were 162 holdings with production in aquaculture. The production was 9,117 metric tonnes of food fish, which when converted to round fresh weight is the equivalent of 10,752 tonnes. Rainbow trout dominated, with 83% of the total production of fish for consumption. The total production of fish for restocking was estimated at 1,073 tonnes, a decrease with 5 % since 2014. The dominating species was rainbow trout.

To compensate for natural reproduction, that has been lost due to hydroelectric power plants, 2.9 million fry of salmon and sea trout were released, mainly in rivers running into the Baltic sea.

TRADE IN LIVE ANIMALS (LIVESTOCK)

The trade of livestock into and from Sweden is limited.

In 2016, 150 live pigs were brought into Sweden from Norway, 13 cattle came from Denmark, and 14 sheep (ARR/ARR) from the Netherlands.

Approximately 0.5 million day-old chicks (*Gallus gallus*) were brought to Sweden from other European countries: Germany, Great Britain, the Netherlands, Denmark, France and Norway.

In addition, 8,320 turkeys (*Meleagris gallopavo*) were brought from Great Britain and 4,504 ducks (*Anas spp.*) from Denmark and Germany, all as day-old chicks. Moreover, 31,502 hatching eggs (*Anas*

spp.) were brought from Denmark and France and 200,556 hatching eggs (*Phasianidae*) from Denmark, Poland and France. 2,440 specific pathogen-free (SPF) hatching eggs (*Gallus gallus*) from Germany were also brought to Sweden.

About 10,000 live birds were imported from Norway and 132 pigs from Denmark to be used for scientific purposes. The birds are included in the numbers above, but not the pigs.

The number of animals that left Sweden for intra-Union trade during 2016 were 125 cattle (including 6 yaks) and 134 sheep. Nine yaks were exported to Norway.

Altogether 7.2 million day-old chicks were sent from Sweden to Belgium, Denmark, Estonia, Lithuania, Poland, Germany, Latvia, the Netherlands and Finland. About 459,000 live poultry (*Gallus gallus*) were sent to Germany, Denmark, Poland and Finland and 8,500 ducks were exported to Norway. About 10.2 million hatching eggs were sent to Germany, Denmark, Norway, Finland, France, the Netherlands and Russia.

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Livsmedelsverket

Animal registers and datasources used in surveillance



THE CENTRAL REGISTER OF HOLDINGS

The Swedish Board of Agriculture is responsible for the Central Register of Holdings (PLATS). Each holding is allocated a unique identification number (holding number). The register contains information on holdings with bovine animals, pigs, sheep, goats, laying hens and other poultry. Details on holding number, address, type of production, capacity and the geographical coordinates of the holding are included, as well as the name, address and telephone number of the keeper. All egg producers with a capacity of at least 350 laying hens and

all those selling eggs for consumption must be registered. The register contains specific information about production method, capacity and the number of houses and sections on the holding.

THE CENTRAL DATABASE OF ANIMAL MOVEMENTS

The Swedish Board of Agriculture is responsible for the Central Database of animal movements. It contains data on all holdings with pigs, sheep and goats and their movements between holdings. The data encompasses address and holding number as well

Figure: Thomas Rosendal. A force directed graph of the 2016 Swedish cattle trade network

as name and telephone number of the keeper. The database contains information from the keepers and the abattoirs. Managers may register movements in the database via the internet, or in paper form. Animals are registered in groups in the database when moved. For sheep and goats both the keeper who dispatches the animals, and the keeper who receives the animals, are responsible for reporting to the database, within seven days of the movement.

THE CENTRAL DATABASE FOR BOVINE ANIMALS

The Swedish Board of Agriculture is responsible for the Central Database for Bovine animals (CDB), to which all bovine births, deaths and movements must be reported. The keeper is responsible for reporting any changes within seven days of the occurrence. The purpose of the register is to allow swift and efficient tracing of a contagious disease, verification of the country of origin of a meat product, as well as control and administration of cross compliance. The system enables the scanning of animal disease forms into the data system.

THE SLAUGHTER REGISTER

The Slaughter Register (SLAKT) is administrated by the Swedish Board of Agriculture. The abattoirs are responsible for reporting all slaughtered animals including wild game. The producer's organisation number or personal code number must be reported for all species except wild game. The holding number of the supplier is compulsory information for all species except horses and wild game. Reports must be made every week.

THE DATABASE FOR DAIRY HERDS

The national coordinating organisation for dairy and beef production is Växa Sverige. The organisation is responsible for the database for dairy herds (Ko-databasen). The database includes milk recordings, fertility results and disease recordings for all animals at the dairy farm. It forms the basis for the development of different management tools used by the farmers, advisers and veterinarians. It is also a valuable tool for research on topics such as: feeding, animal health and genetics. Approximately 85% of

all dairy cows in Sweden are included in this recording program. Växa Sverige is further organising the surveillance programmes for bovine leucosis and infectious bovine rhinotracheitis. It is also organising the eradication programme for bovine viral diarrhoea virus and a voluntary control programme for salmonellosis in bovines. Since the autumn of 2015 the programme for salmonellosis gradually is replaced with a more general biosecurity programme for bovines (Smittsäkrad besättning).

THE ANIMAL HEALTH DATABASE

The Swedish board of Agriculture is responsible for the animal health database (vet@) which is used by the veterinary services for the documentation of the health situation on farms, including details about health status, treatment and vaccinations of individual animals. It is based on reports from practitioners to the Swedish Board of Agriculture. All veterinarians are obliged to continuously report activities of their veterinary practice on production animals. The purpose is to monitor the animal health situation in Sweden and use it as a base for preventive measures.

CENTRAL AQUACULTURE REGISTER

All Aquaculture premises authorised by the county administrative board are registered in the Central Aquaculture Register. The register is administrated by the Swedish Board of Agriculture. The data encompasses name and coordinates of the premise as well as type of production and species kept. It also contains results from official controls, information on the farm's water supply and discharge as well as date information on health status.

THE POULTRY REGISTER

The Swedish board of Agriculture is responsible for the poultry register, which includes data on commercial holdings with ducks, pigeons, pheasants, geese, mallard ducks, chickens, turkeys, guinea fowl, partridges, ratites or quails. The purpose of the register is to allow swift and efficient tracing of contagious diseases (i.e. avian influenza and Newcastle disease). The register encompasses information about the location of the holding, contact information, type of production, species, maximum capacity, number of units on the site etc.

Institutions, organisations and laboratories involved in monitoring



Photo: Linda Svensson

SWEDISH BOARD OF AGRICULTURE

The Swedish Board of Agriculture (SBA) is the Government's expert authority in the field of agricultural and food policy, and is responsible for agriculture, aquaculture and horticulture, including Animal and plant health. This includes monitoring, analysing and reporting to the Government on developments in these areas, and implementing policy decisions within its designated field of activities. The aim is to fulfil the overall goals of the agro-food policy and promote food production that is competitive, adapted to environmental and animal welfare concerns, and that benefits consumers.

The SBA promotes animal health by prevention and control of contagious animal diseases. This includes feed, animal by-products and animal health personnel. SBA is also the central authority for animal welfare issues. The SBA district veterinarians represent a substantial part of the organisation, and constitute the principal body for performing official

veterinary controls and for emergency measures to combat contagious diseases. In addition to their official tasks, the district veterinarians also do clinical work and are involved in preventive health care.

NATIONAL VETERINARY INSTITUTE

The National Veterinary Institute, SVA, is a Swedish national authority that strives for good animal and human health, a good environment and sustainable food production. SVA is an expert authority under the Swedish Ministry of Enterprise and Innovation, and is the nation's leading knowledge centre for infectious diseases in veterinary medicine with expertise within pathology, microbiology, diagnostics, risk assessment, prevention and control of contagious animal diseases and other serious infectious diseases including zoonotic agents and antimicrobial resistance.

SVA works in four areas: Disease monitoring and contingency planning, diagnostics and analysis,

research and development and knowledge communication.

Several control- and monitoring programmes are conducted in cooperation with stakeholder organisations and relevant authorities. SVA outlines the national surveillance plan that is confirmed and enacted by the SBA.

THE PUBLIC HEALTH AGENCY OF SWEDEN

The Public Health Agency of Sweden is a government agency accountable to the Government. This authority operates across the public health spectrum and integrates communicable disease control with other public health work. It aims to identify and highlight public health issues where effective interventions can be made. The authority collaborates with other authorities, county councils and municipalities to develop a national knowledge support and to follow up interventions. The Public Health Agency of Sweden promotes health and prevents diseases by supporting communicable disease control with epidemiological and microbiological analyses. The authority also focuses on preparedness for outbreaks of severe infectious diseases, both within the country and outside the borders. Diagnostic analyses of different bacteria, viruses and parasites, as well as water and environmental analyses are carried out by the authority.

NATIONAL FOOD AGENCY

The National Food Agency (NFA) is a federal agency under the Ministry for Enterprise and Innovation. The NFA works in the interest of the consumer to ensure food safety, to promote fair practices in food trade and to promote healthy eating habits. To accomplish this mission, the agency develops and issues regulations, advice and information as well as coordinates and carries out control. As a basis for these activities the agency performs risk and benefits analyses, collects data on food consumption and composition, and carries out microbiological, chemical and nutritional analyses on food and water. The NFA is also responsible for environmental issues, emergency preparedness, and coordination of drinking water control.

COUNTY ADMINISTRATIVE BOARD

Sweden is divided into 21 counties, each of which has its own County Administration and County Governor. The County Administrative Board is an important link between the people and the municipal

authorities on the one hand and the government, parliament and central authorities on the other. The county administrations have important coordinating functions for prevention, surveillance and eradication of contagious diseases.

DAIRY SWEDEN

Dairy Sweden is the national industry organisation for Swedish dairy farmers and the Swedish dairy industry. Dairy Sweden works on behalf of its owners, who are the six largest dairy companies in Sweden. These companies represent more than 98% of Swedish milk production, including three livestock cooperatives (one of them is Växa Sverige). Dairy Sweden gathers, develops and communicates knowledge relating to the entire chain from cow to consumer, including animal health.

FARM & ANIMAL HEALTH

Farm & Animal Health is an advisory company owned by the main meat producing companies and the farmer organisations for pigs, beef and sheep in Sweden. The aim is to maintain a high level of health in an effective profitable production in the pig, beef and sheep sectors. The company's business idea originates from the 1960's and is to promote healthy animals for profitable farming. Focus is to prevent animal health problems for pigs, cattle (for meat production) and sheep as well as to improve animal welfare.

The activities are performed with a clear national focus and the consulting services are open to all farmers. A large part of the activities and services are based on officially approved animal health programmes for pigs, cattle and sheep. In addition, Farm & Animal Health is assigned by the Swedish Board of Agriculture to perform specific disease control and surveillance programmes. Examples of such programmes are surveillance of porcine reproductive and respiratory syndrome virus in pigs, the control of maedi-visna in sheep and Johne's disease in cattle, monitoring of antimicrobial resistance in disease-causing bacteria and the national post-mortem programme of livestock animals.

Applied research and development are important parts of the business and projects are often performed in collaboration with the National Veterinary Institute and the Swedish University of Agricultural Sciences.

LUNDEN ANIMAL HEALTH ORGANISATION

Lunden Animal Health Organisation is a veterinary consulting company working with pig health and welfare. The objective is to gather, develop and communicate knowledge associated with pig issues. The organisation is part of the national surveillance programme for pig diseases and has permission to perform health control as well as administrating a voluntary Salmonella control programme.

SWEDISH POULTRY MEAT ASSOCIATION

Swedish Poultry Meat Association (SPMA) represents 99.5 % of the poultry meat production of chicken, turkey, goose and duck in Sweden, with members from the entire production chain. The members are obligated to participate in the animal welfare and health programmes, administered by SPMA such as control for Salmonella, Campylobacter, coccidiosis and clostridiosis, to meet high standards for food hygiene and safety.

The SPMA is multifunctional; the major task is the work associated with economic and political industry related matters important to its members. SPMA receives legislative referrals from the Swedish public authorities and the EU's institutions. The organisation also initiates and economically supports research.

THE SWEDISH EGG ASSOCIATION

The Swedish Egg Association is the national organisation for Swedish egg producers, hatcheries, rearing companies, egg packing stations and feeding

companies and represents 94% of the total Swedish egg production.

The Swedish Egg Association is responsible for the organisation of the the surveillance programmes for animal health and welfare and the voluntary Salmonella control programme. The objective is to support profitable egg production, with a high standard of animal welfare, food hygiene and safety.

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Disease Surveillance 2016

Atrophic rhinitis

BACKGROUND

Atrophic rhinitis (AR) is caused by toxin-producing strains of *Pasteurella multocida*. Since *P. multocida* is a secondary invader and not capable of penetrating an intact mucosa, it is dependent on other infections. Traditionally, *Bordetella bronchiseptica* has been considered the most important precursor, but other bacteria and viruses may also precede *P. multocida* infection. Atrophic rhinitis was a common disease in pig production but improvements in rearing and disease prevention have caused the disease to gradually fade away. Farm & Animal Health administers a control programme which has been in place since 1995.

DISEASE

When *P. multocida* penetrates the nasal mucosa, its toxins can affect the bone building process and the snout may progressively become twisted. Affected pigs will also show retarded growth. *P. multocida* can also damage the nasal epithelium and cilia causing inhaled air to reach the respiratory organs without being filtered or warmed, which in turn increases the risk for other respiratory infections.

LEGISLATION

Atrophic rhinitis is a notifiable disease according to SJVFS 2013:23.

SURVEILLANCE

The purpose of the control programme is to declare herds selling breeding stock free from infection with

toxigenic *P. multocida*, and thereby decrease the incidence of AR in all herds. Nucleus and multiplying herds are actively controlled for the presence of toxigenic *P. multocida* at least once a year and every time there is clinical suspicion of AR. Eradication of *P. multocida* is not realistic since it is an ubiquitous bacterium that can affect all mammals. However, anytime AR is suspected in a herd, tests should be performed for the presence of toxigenic *P. multocida*. If toxigenic *P. multocida* is detected, the health declaration is withdrawn and restrictions on the sale of pigs are put in place until the herd is sanitised and declared free from the disease. Diagnostic tools developed by DAKO (Copenhagen, Denmark) and evaluated at SVA during the late 1980s and early 1990s offered the possibility to combat AR in an effective way. Nasal swabs are cultured on a special media overnight. The entire microbial growth is harvested and diluted in water and the presence of the *P. multocida* toxin is assessed by an ELISA system.

RESULTS AND DISCUSSION

Atrophic rhinitis used to be a common disease, but the disease is now very rare due to efforts made in the early 1990s and the control programme that was initiated in 1995. The last Swedish herd was diagnosed with AR in 2005 (Table 1). In 2009, *P. multocida* was detected in 10 out of 34 imported Norwegian boars in quarantine. These boars were isolated and found negative for *P. multocida* at re-sampling before moved to a boar station as intended.

Table 1: The total number of samples and the outcome of nasal swabs analysed for *P. multocida* 2005-2016. The samples have been collected in all nucleus and multiplying herds, as well as in production herds suspected for AR.

Year	Samples	Positive samples	Diagnosed herds
2005	2,413	29	2
2006	1,836	2	0
2007	1,878	1	0
2008	462	0	0
2009	1,724	10	1
2010	1,523	0	0
2011	1,323	0	0
2012	1,431	0	0
2013	1,027	0	0
2014	1,050	0	0
2015	844	0	0
2016	976	0	0

Aujeszky's disease

BACKGROUND

Aujeszky's disease (AD) is caused by a herpes virus with the capacity to infect several species but pigs are the natural host. The disease is of importance for pig production worldwide although it is controlled in many countries, at least in the domestic pig population. AD is widespread in the wild boar populations in Europe and wild boars are reported to develop clinical signs of disease and could act as reservoirs, but their role in transmitting the disease is not well known. Other species, including cattle, sheep, goats, dogs and cats, develop clinical signs but are not of importance for the transmission of the disease, but rather considered as dead-end hosts. A few cases of human infection have been reported but AD is not considered a zoonotic disease.

Sweden has been officially free from AD since 1996 (Commission Decision 96/725/EU with amendments). This status was achieved following a national, government-supported control programme, that was introduced in 1991 and operated by Farm & Animal Health. Farm & Animal Health is also responsible for the ongoing active surveillance programme reported to the Swedish Board of Agriculture.

DISEASE

The clinical presentation of AD is different depending on the age of the infected animal. The most severe clinical signs develop in newborn or very young piglets in which infection leads to neurological signs and nearly 100% mortality, whereas adult pigs show only mild respiratory signs and inappetence. In addition to the mild clinical signs, pregnant sows can abort as a consequence of the infection. Species other than pigs develop neurological signs including severe itch ("mad itch") and die within 1-2 days.

LEGISLATION

The disease is included in the Swedish Act of Epizootic diseases (SFS 1999:657 with amendments) and is thereby notifiable on clinical suspicion for all veterinarians and farmers. Sweden has been granted certain additional guarantees regarding AD by the European Commission, in order to protect the Swedish pig health status (Decision 2008/185/EC).

SURVEILLANCE

The purpose of the surveillance is to document continued freedom from the disease. Samples are analysed for antibodies against the AD virus using a blocking ELISA (Svanovir™, PRV-gB-Ab ELISA, Svanova) and in the case of clinical suspicion also for virus or viral genome. All analyses are performed at the National Veterinary Institute.

Passive surveillance

As AD is notifiable on clinical suspicion for both veterinarians and farmers, cases with clinical signs consistent with AD will be investigated following notification to the Swedish Board of Agriculture. The investigation includes sampling of sick or dead animals and examination of the herd for presence of clinical signs and analyses of production results. The farm is placed under restrictions during the investigation.

Active surveillance

In 2016, the samples collected in the abattoir sampling part of the surveillance carried out by the Farm & Animal Health for porcine respiratory and reproductive syndrome virus (PRRSV) were used for the active surveillance for AD. See chapter on PRRS for details on sampling and population.

In addition to the surveillance of AD in domestic pigs there is also an active surveillance of AD in wild boar, see chapter Infectious diseases in wild boars.

RESULTS

Passive surveillance

During 2016, two clinical suspicions of AD were investigated, one pig herd and one fox. In the pig herd, late abortions of weak piglets that died within hours, some with neurological signs, was the main clinical manifestation. Adult animals showed no clinical signs consistent with AD. Organ samples from dead piglets and blood samples from sows were analysed for virus genome and for antibodies to AD, classical swine fever and PRRSV. Following sampling and testing, the herd was declared negative for AD. The fox was examined for AD because non-purulent meningoencephalitis was detected at histopathological examination. All analyses were negative for AD.

Active surveillance

In 2016, 2,418 samples corresponding to 3 samples per herd at 806 sampling occasions were analysed within the active surveillance programme. Each herd was as a rule sampled 1-2 times during the year. All samples were negative for antibodies to the AD virus.

DISCUSSION

The purpose of the surveillance is to document freedom from the disease and to contribute to the maintenance of this situation by detection of an introduction of the disease before it is widely spread in the swine population. The design of the active surveillance has been changed several times since 2007 and since 2011 the AD surveillance is based solely on abattoir sampling in the PRRS surveillance programme. The effects on probability of freedom and sensitivity of the surveillance of these changes have not been evaluated (Table 2).

Table 2: Number of samples and sampling population included in the active surveillance of Aujeszky's disease 2007-2016.

Year	Sampling population	Number of samples
2007	Boars and sows at slaughter	4,529
2008	Boars and sows at slaughter	3,612
2009	Boars and sows at slaughter	776
2009	Fatteners at slaughter	2,712
2010	Field sampling of nucleus herds, multiplying herds and sow pools	1,070
2010	Abattoir sampling	4,371
2011	Abattoir sampling	2,308
2012	Abattoir sampling	2,152
2013	Abattoir sampling	1,548
2014	Abattoir sampling	2,028
2015	Abattoir sampling	2,383
2016	Abattoir sampling	2,418

Bluetongue

BACKGROUND

Bluetongue is a vector borne disease of ruminants and camelids caused by any of 27 serotypes of bluetongue virus (BTV). The virus is transmitted by haematophagous midges (*Culicoides* spp).

Until 1998, bluetongue had not been detected in any European country but since then, outbreaks of several serotypes have frequently been detected in the Mediterranean countries. In August 2006, BTV-8 appeared in the Netherlands. During 2006 and 2007 this outbreak spread to a large number of countries in Northern and Western Europe. In 2008, further cases were reported and vaccination campaigns were launched in most of EU as soon as inactivated vaccines became available. In September 2008, the first case of BTV-8 infection in Sweden was confirmed. A vaccination campaign and intensive surveillance activities were initiated nationally, with focus on the southern part of the country. Following the detection of infected animals in new areas, the zones were adjusted accordingly. Vaccination and surveillance activities continued in 2009. In the first quarter of 2009 transplacental infection was detected in three newborn calves, all three cases originating from infections of their dams in autumn 2008.

In December 2010, after extensive surveillance, Sweden was declared free from BTV-8. After that, surveillance according to Commission Regulation (EC) No 1266/2007, with amendments, has been carried out annually.

DISEASE

BTV causes clinical disease in ruminants, mainly in sheep. The different serotypes appear to vary in their ability to cause clinical signs in different animal species and also in the severity of clinical signs in the same species. The signs include fever, lesions in the mucous membranes of the mouth and nostrils, inflammation of the coronary band, swollen head and oedema in various body tissues.

LEGISLATION

The control, monitoring, surveillance and restriction of movements of certain animals of susceptible species are governed by Regulation 1266/2007 with amendments. Bluetongue is a notifiable disease and

is included in the Swedish Act of Epizootic diseases (SFS 1999:657 with amendments).

SURVEILLANCE

All diagnostic testing, as outlined below, was performed at the National Veterinary Institute. Serum samples were analysed with a competitive ELISA (ID Screen Bluetongue Competition ELISA) and milk samples were analysed with an indirect ELISA (ID Screen Bluetongue Milk). Organs and blood were analysed with real-time pan-PCR detecting 24 serotypes.

A positive case is defined as an animal giving rise to a positive PCR-product or an unvaccinated animal without remaining maternal antibodies giving a significant antibody titre.

Passive surveillance

Suspicious based on clinical signs must be reported to the Swedish Board of Agriculture and will be subsequently investigated.

Active surveillance

Vectors

Vector surveillance was initiated in 2007 in order to document the activity of relevant *Culicoides* spp. throughout the different seasons of the year. The programme was discontinued in 2011 after Sweden was declared free from BTV-8.

Animals

For the 2016, bluetongue surveillance, approximately 1,400 animals from 140 herds geographically spread over the country were selected for testing. The number of holdings tested was distributed among the state district veterinarians in accordance with the cattle density in each county. Ten animals from each holding were selected for testing by the sampling veterinarian according to the following inclusion criteria: lactating, unvaccinated, having grazed (been exposed to the vector) during the last season. The sampling took place after the vector season, from December 2016 until January 2017 and samples were analysed with the milk ELISA routinely used. The number of tested herds was sufficient to detect 2 % prevalence with 95% confidence.

In addition to the surveillance programme, serological testing for bluetongue prior to import and export, and at breeding centres was performed.

RESULTS

Two clinically suspect cases were investigated and tested during 2016, and found negative. The outcome of all other testing performed in 2016 was also negative.

DISCUSSION

In summary, no clinical suspicions of bluetongue were confirmed nor was there any indication of viral circulation during 2016.

Competent vectors are present in Sweden and may spread the infection. Reintroduction of the virus to Sweden may occur by infected animals, infected vectors or other yet unidentified means.

At present, there are no indications of BTV-8 circulation in neighbouring countries. However in 2015, France reported that BTV-8, of the Northern European strain from 2007, had re-emerged in the central parts of the country. Between September 2015 and February 2017 several thousands (1,924) of outbreaks (an outbreak in this case being defined as one animal found positive for BTV with real time PCR) were reported. Most of these outbreaks refer to animals found positive within active surveillance activities. During the vector season of 2016, 59 out of in total 1,740 confirmed outbreaks were animals with clinical signs of BTV. No additional countries reported outbreaks of BTV-8 during the vector season of 2016.

During 2012 BTV-14, was detected in cattle in Estonia, Latvia, Lithuania, Poland and Russia. Sequencing was performed and indicated that the positive cases were derived from a common source and suggested significant spread of the virus in the field.

The strain was identified as a BTV-14 reference or vaccine strain, possibly indicating the use of a live BTV-14 vaccine.

The detection of BTV-8 in France in 2015 after several years of silence, and the numerous cases detected during 2016, again demonstrates that BTV may spread and become established in livestock populations in Europe. Moreover, as national vaccination campaigns in northern Europe are ceasing and the prevalence of seropositive animals decline, the population will again become susceptible to BTV-8. Therefore, new introductions of this serotype, or any remaining foci in previously infected countries, could pose a threat. Likewise, new serotypes could emerge in the Mediterranean region or start circulating worldwide, underlining how the situation can change rapidly.

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Bovine spongiform encephalopathy



Photo: Bengt Ekberg/SVA

BACKGROUND

Classical bovine spongiform encephalopathy (BSE) belongs to a group of diseases called transmissible spongiform encephalopathies (TSE). It was first described in cattle in the UK in 1986 and from there the disease spread to a large number of European countries as well as countries outside Europe. The current theory about the causative agent is the protein-only hypothesis. This theory assumes that misfolded prions (small proteins) induce the same misfolded structure in normal proteins in the body of the host, resulting in accumulation of prions and cellular damage without involvement of any microorganism. Classical BSE primarily spread through contaminated meat and bone meal (MBM), i.e. MBM containing parts of animals infected with BSE. However, the primary source of the epidemic was never established.

In 1996, the disease became a public health concern, after the detection of a new variant of Creutzfeldt-Jacob Disease in humans (vCJD), likely to be linked to classical BSE in cattle. This resulted

in actions taken to prevent transmission to humans through removal of specified risk material (such as brain and spinal cord) from cattle at slaughter, restrictions related to feed to avoid recycling of infectious material to ruminants through infected MBM and an intensified surveillance which started in 2001 after rapid diagnostic tests became available.

Atypical strains of BSE, which show diagnostic dissimilarities with classical BSE, have been described. These atypical BSE cases probably occur spontaneously and possible links to classical BSE and potential zoonotic aspects are being discussed.

Sweden has historically had a low risk of introduction of classical BSE and a low risk of recirculation of the disease if it had been introduced, due to an early ban on the use of fallen stock in production of feed for livestock and limited imports. This has been assessed by the Scientific Steering Committee, by the European Food Safety Authority (EFSA), and later by the OIE Scientific Commission and expressed in terms of the Geographical Bovine spongiform encephalopathy Risk (GBR). Sweden is

currently, recognised as having a negligible risk for classical BSE, as a result of a resolution adopted by the OIE International Committee.

One case of BSE has been detected in cattle in Sweden. This was in 2006 in a beef cow born in 1994. This case was confirmed to be atypical BSE of the H-type, i.e. not classical BSE.

DISEASE

The incubation period is long, from two years up to several years. Clinical signs are related to the neurological system and include altered behaviour and sensation as well as affected movement and posture. The clinical state can last for weeks or months. The disease is progressive and always fatal.

LEGISLATION

Surveillance and control is regulated through the Regulation (EC) No 999/2001 of the European Parliament and of the Council of 22 May 2001; on national level the sampling is regulated by SJVFS 2010:9, last amended through SJVFS 2013:3. BSE is a notifiable disease under the Swedish Act of Epizootic diseases (SFS 1999:657, with amendments) and there is a scheme to compensate farmers for losses due to eradication measures.

SURVEILLANCE

Feed

In order to survey compliance with the feed bans, samples of imported raw material for feed production are collected at feed mills and at the farm level and analysed for the presence of MBM using microscopy, according to Regulation (EC) 152/2009. The Swedish Board of Agriculture and the County Administrative Boards are responsible for this surveillance.

Animals

The Swedish Board of Agriculture is responsible for the surveillance programme, carried out in cooperation with the National Veterinary Institute which is the National Reference Laboratory, NRL (Regulation (EC) 999/2001). Samples are analysed at the National Veterinary Institute.

Passive surveillance

All suspicions of BSE (bovine animals not responding to treatment, with clinical signs that are compatible with a BSE diagnosis) must be reported to the authorities. The obligation to report applies for animal owners, veterinarians and everyone else who is

responsible for the animals. Samples are analysed with Bio-Rad TeSeE short assay protocol (SAP) in combination with Bio-Rad TeSeE Western Blot.

Active surveillance

The surveillance design is in accordance with Regulation (EC) No 999/2001 Annex III and Sweden applies derogation for remote areas with low density of cattle in accordance with Commission Decision 2008/908.

The following categories were sampled in the active surveillance:

Cattle of Swedish origin, above 48 months of age, that have remarks at antemortem inspection before slaughter or are emergency slaughtered.

Cattle of other than Swedish origin above 24 months of age that have remarks at antemortem inspection before slaughter or are emergency slaughtered.

All slaughtered cattle above 30 months of age that originate in a country other than Sweden, which does not have negligible risk for BSE.

All fallen stock (animals dead or killed on farm but not slaughtered for human consumption) above 48 months of age that originate from Sweden. For cattle that originate from a country other than Sweden which does not have a negligible risk for BSE, the age limit for sampling is 24 months. The fallen stock are sampled at the rendering plants or at necropsy. Sweden applies derogation (Regulation (EC) 999/2001) for remote areas with a low cattle density, where no collection of dead animals is organised. The cattle population in these areas does not exceed 10% of the total bovine population in Sweden.

All samples were examined with Bio-Rad TeSeE SAP. In case of positive or inconclusive results the material was prepared and examined with Bio-Rad TeSeE Western Blot.

RESULTS

Feed

In 2016, 38 feed samples were taken at feed mills; 19 of these were from feed (18 were cattle feed) and 19 from raw materials for feed production. All of these samples were negative. No samples were collected in primary production during 2016.

Animals

Passive surveillance

In 2016, two cattle were examined due to clinical suspicion, both with negative results.

Active surveillance

In 2016, 8,957 samples were examined for BSE. All samples were negative. Of these samples 8,747 were from fallen stock, 20 samples were from animals with remarks at antemortem inspection before slaughter and 190 samples were from emergency slaughtered animals.

DISCUSSION

No positive BSE cases were detected. During 2016, preventive measures have been in place for many years and the fact that no cases were detected supports that these measures have been effective. The low number of clinical suspicions may be an indication of a lower degree of awareness among farmers and veterinarians compared to 10-15 years ago.

Reports of prion transmission studies, including several passages in different species, have shown that prion-strains do not always remain stable through these passages. The source of the large epidemic of classical BSE has not been determined and atypical cases cannot be excluded as the source. Thus, the atypical cases may be a potential source of a new epidemic. As the number of cases of classical BSE is decreasing within the European Union, surveillance is decreasing and suggestions have been made to allow the use of MBM in feed within the EU. However, strict separation and bans of these feeding practices must be kept in place to

avoid any possibility of recirculation of BSE if the disease agent were to enter the system again. Recent international reports of a few cases of classical BSE in young animals born long after implementation of the strict feed ban indicates either problems with the ban or that there are other causes of classical BSE which we yet do not have knowledge of. The last chapter in the BSE history has not yet been written.

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Bovine viral diarrhoea



Photo: Linda Svensson

BACKGROUND

Bovine viral diarrhoea (BVD) is caused by bovine viral diarrhoea virus (BVDV), which is classified in the genus Pestivirus and the family Flaviviridae. Cattle are the primary host of BVDV, but most even-toed ungulates are likely to be susceptible to the disease. Cattle that are persistently infected serve as a natural reservoir for the virus. The virus may spread between animals via direct or indirect routes. A voluntary surveillance and control programme with the objective to eradicate BVD without vaccination was launched by the Swedish Dairy Association in 1993. The government and the farmers share the costs for sampling and testing. Since June 2001, there is also a compulsory control programme requiring all cattle herds to be tested for BVDV on a regular basis. Since 2014, Sweden is considered free from BVD.

DISEASE

BVDV may induce disease of varying severity, duration and clinical signs after an incubation period of 6-12 days. Fever, depression, respiratory distress, diarrhoea are typical signs of acute BVD. In pregnant cattle, infection may result in reproductive failure such as abortion, stillbirth or the birth of calves that are persistently infected with the virus. A more uncommon form of BVD is mucosal disease, that may occur in an acute or chronic form in persistently infected animals.

LEGISLATION

BVD is a notifiable disease according to SJVFS 2013:23. The voluntary control is regulated through SJVFS 1993:42 and the compulsory control in SJVFS 2002:31.

SURVEILLANCE

Herds are individually risk categorised based on the number of herds they have purchased from and sold to during the preceding 12-month period.

Surveillance of dairy herds is performed by sampling bulk milk in conjunction with milk quality testing. The laboratory gets an order from Växa Sverige (the former Swedish Dairy Association) about which herds to sample. All samples are marked using bar code labels. Surveillance of beef herds is performed by blood sampling at slaughter. Field testing can also be carried out as a backup component if herds to be tested cannot be accessed through the abattoir or through sampling of bulk milk. The scheme is designed to detect the presence of infection at a herd design prevalence of 0.2%, with 99% confidence. The within-herd design prevalence is set to 30%. In case of re-appearance of BVD, herds that are infected will be screened, and persistently infected virus carriers identified and removed. Details on numbers of samples and herds tested 2016 are given in Tables 3 and 4.

Diagnostic testing is performed at the National Veterinary Institute. For screening, an indirect antibody ELISA (Svanovir® BVDV-Ab ELISA) is used on serum, milk and bulk milk samples. Presence of virus is analyzed by an in-house IPX (immunoperoxidase) or PCR tests.

An evaluation of the probability of freedom from BVDV in Swedish cattle was performed in 2016. The assessment was completed using a scenario tree modelling approach on the total surveillance activities from 2012 through 2015. In the model, the probability of introduction of the disease into Sweden was estimated based on the number of live animals imported from other EU countries and the prevalence of BVDV in the exporting country.

RESULTS

Numbers of antibody positive bulk milk, slaughter, and field samples tested in 2016 are given in Table 3. As shown in Table 4, two herds (both beef herds) were antibody positive during the year. These herds were investigated and considered to be non-infected.

In 2016, no newly infected herds were identified and no virus positive animals were born.

The scenario tree model of the surveillance for BVDV in Swedish cattle indicated that the quarterly surveillance system sensitivity varied between 72% and 99.9% and the probability of freedom from the disease in Swedish cattle at the end of 2015 was 99.96%.

DISCUSSION

All herds in Sweden were affiliated to the voluntary or compulsory programmes during 2016. At the end of the year, no herd was diagnosed to have an ongoing BVDV-infection. A newly infected herd has not been detected since 2011, and the last virus positive animal was born in an infected dairy herd in 2012. Since 2014, Sweden is considered free from BVDV. Continued surveillance is necessary to maintain confidence in freedom from the disease.

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Table 3: Total numbers of samples with different contents of BVDV antibodies tested in 2016.

Sample type	Class/Finding	Herds	Animals
Bulk milk	0-1 ^A	2,494	-
Bulk milk	2-3 ^A	0	-
Blood sample at slaughter	Negative	-	12,155
Blood sample at slaughter	Positive	-	2
Field sample	Negative	-	8
Field sample	Positive	-	0

^A Class 0-1 = no or very low levels of antibodies; Class 2-3 = moderate or high levels of antibodies.

Table 4: Dairy and beef herd results from testing of BVDV antibodies in bulk milk or blood samples in 2016 divided by herd level risk

Herd level risk ^A	Herd numbers (N)	Production type	
		Dairy	Beef
<i>Low risk</i>	N of herds	2,551	7,931
	N of herds tested	983	1,945
	N positive	0	0
<i>Medium risk</i>	N of herds	1,285	1,621
	N of herds tested	1,192	1,008
	N positive	0	0
<i>High risk</i>	N of herds	341	600
	N of herds tested	319	316
	N positive	0	2

^A Based on the number of herds they have purchased from and sold to during the preceding 12 month period

Brucellosis

BACKGROUND

Brucellosis is caused by a zoonotic, gram-negative bacterium belonging to the genus *Brucella*. Most human cases are caused by four species, each having a preferred animal host. *Brucella melitensis* occurs mainly in sheep and goats, *Brucella suis* in pigs, *Brucella abortus* in cattle and *Brucella canis* in dogs. The infection is transmitted by contact with placenta, foetus, foetal fluids and vaginal discharges from infected animals and may also be found in milk, urine, semen and faeces. *In utero* infections occur, however, venereal transmission seems to be uncommon. Humans are usually infected through contact with infected animals or contaminated animal products, such as cheese made of unpasteurised milk.

Brucellosis was eradicated from the Swedish cattle population during the first half of the last century. The last Swedish bovine case was recorded in 1957. Brucellosis in humans has been a notifiable disease in Sweden since 2004. Between 4 and 19 human cases have been reported annually. Most of these patients have acquired the infection outside Sweden or via consuming products from endemic countries.

DISEASE

Animals

In animals, brucellosis mainly causes reproductive disorders such as abortion, orchitis and epididymitis. Arthritis is occasionally seen in both sexes. Systemic signs and deaths are rare, except in the foetus or newborn. The period between infection and abortion or other reproductive signs is variable. Infected asymptomatic females may shed the organism in milk and uterine discharges.

Humans

B. melitensis is considered to be the most severe human pathogen in the genus. Brucellosis in humans can be asymptomatic, but the course of the illness is extremely variable and the clinical signs may appear insidiously or abruptly. Typically, brucellosis begins as an acute febrile illness with nonspecific flu-like signs such as fever, headache, malaise, back pain, myalgia and generalised aches. Some patients recover spontaneously, while others develop persistent symptoms that typically wax and wane.

Genitourinary involvement occurs in 2-20% of the human cases. The mortality rate is low, around 2%.

LEGISLATION

Animals

Brucellosis in food-producing animals is included in the Swedish Act of Epizootic diseases (SFS 1999:657 with amendments). Vaccination is prohibited and notification of suspect cases is mandatory. Sweden's bovine brucellosis free status has been officially stated in EU legislation since 1994, Decision 2003/467/EC. Ovine brucellosis is encompassed by Directive 91/68/EEC. Sweden was declared officially free from brucellosis in sheep and goats in 1995, Decision 94/972/EC.

Current surveillance standards for bovine and ovine brucellosis are given in the EU legislation, Directive 64/432/EEC and Directive 91/68/EEC, respectively.

Brucellosis in non-food-producing animals is not included in the Swedish Act of Epizootic diseases but is still notifiable.

Humans

Brucellosis has been a notifiable disease since 2004 according to the Communicable Disease Act (SFS 2004:168 with the amendments of SFS 2013:634).

SURVEILLANCE

Animals

The purpose of the surveillance activities is to document freedom from bovine and ovine brucellosis in Sweden in accordance with the EU legislation and to further document freedom from the disease in the Swedish pig population. The Swedish Board of Agriculture finances the surveillance, which is planned and executed by the National Veterinary Institute. Since the start of the screenings, no samples have been confirmed positive. All diagnostic testing is performed at the National Veterinary Institute. Bovine samples (serum and milk) are tested with an ELISA, and porcine, ovine or caprine samples (serum) are tested with the Rose Bengal Test (RBT). In case of positive reactions in the ELISA or RBT, serum samples are confirmed with Complement Fixation Test (CFT). For positive bovine milk samples, serum samples are requested for re-testing with the ELISA.

Diagnostic tests for animals with clinical signs suggesting brucellosis, animals included in the passive postmortem surveillance programme or animals that are to be exported/imported will often be tested with the same diagnostic tests as used in the Swedish surveillance programme. For rare species, CFT is most commonly used and Rapid Slide Agglutination Test (RSAT) is the most common test for dogs. A positive case is defined as an animal from which *Brucella* spp. has been isolated, or an animal with a confirmed positive serological reaction.

Passive surveillance

Animals

Suspicious based on clinical signs in food producing animals must be reported to the Swedish Board of Agriculture and will be subsequently investigated. In addition, culture for *Brucella* spp. is included in the enhanced passive surveillance of aborted foetuses of ruminants and pigs (Page 129).

Brucellosis in dogs is not included in the Swedish Act of Epizootic diseases and the zoonotic potential of *B. canis* is considered to be significantly smaller than that of *B. abortus* or *B. melitensis*. Nevertheless, confirmed cases of infection with *B. canis* are notifiable and cases have also been investigated and put under restrictions by the Swedish Board of Agriculture. Imported dogs or dogs mated abroad are seen as a risk factor for introduction of *B. canis* into Sweden.

Humans

Surveillance in humans is passive. Diagnosis of human cases is made by detection of *Brucella* species in blood, bone marrow, bronchoalveolar lavage, biopsy, pleural effusion or urine or by detection of antibodies in blood. The bacteria are isolated by culture of clinical samples, and identified by direct real-time PCR on the samples or from colonies.

Active surveillance

Animals

Screening for *B. abortus* has been conducted regularly in Sweden since 1988, for *B. melitensis* since 1995 and for *B. suis* since 1996.

Ongoing serological testing of all susceptible species prior to export, and in bulls and boars at semen collection centres, adds to the active disease surveillance of *Brucella* spp.

Surveillance for brucellosis in cattle

From 1997 and onwards, approximately 3,000 samples (bulk milk and/or serum samples) have been tested each year for antibodies against *B. abortus*. Samples have been collected within the surveillance programmes for bovine virus diarrhoea and enzootic bovine leucosis and obtained from those samples by convenience sampling (in other words not strictly random), evenly distributed throughout the sampling period. This sampling is, since 2010, conducted every third year and was thus performed in 2016.

The bovine surveillance of 2016 was designed with a between-herd design prevalence of 0.2%, a within-herd design prevalence of 40% and a risk of introduction of 1 in 50 years. Sample size is calculated on a yearly basis to reach a probability of freedom of 99% at the end of the year. To reach this level of probability of freedom, 4,300 samples over the year (1 sample per herd from 4,300 herds per year) is needed.

Surveillance for brucellosis in sheep and goats

Serum samples were tested for antibodies against *B. melitensis*. The sheep serum samples were collected within the surveillance programme for Maedi/Visna and the goat serum samples were collected within the Caprine Arthritis Encephalitis programme. The samples were obtained from those samples by convenience sampling (in other words not strictly random).

The ovine and caprine surveillance of 2016 was designed with a between-herd design prevalence of 0.2%, a within-herd prevalence of 40% and a risk of introduction of 1 in 25 years. Sample size is calculated on a yearly basis to reach a probability of freedom of 95% at the end of the year. To reach this level of probability of freedom, 2,000 samples over the year (5 samples per herd from 400 herds per year) is needed.

Surveillance for brucellosis in pigs

From 1996 until 2008 approximately 3,000 serum samples from pigs have been tested for antibodies against *B. suis* each year. Beginning in 2009, serum samples are tested every second year, and accordingly, this sampling will be performed next time in 2017.

RESULTS

Passive surveillance

Animals

During 2016, no clinical suspicion was seen in any animal species.

Within the surveillance of aborted foetuses, 34 bovine, 16 ovine, two caprine, one alpaca, one bison and 43 pig foetuses were examined for *Brucella* spp. All samples were negative.

Humans

For many years, no domestic cases were reported and Sweden is therefore considered free from brucellosis. However, since 2010 there has been approximately one domestic case reported annually. Two of the cases were believed to have been infected while consuming contaminated products from Afghanistan, 2010 (milk powder) and Iraq, 2012 (green cheese). Also during 2011, a domestic case was reported which was not actually infected in Sweden. This case was a child born in Sweden to a mother infected in Syria while she was pregnant. *Brucella* was isolated in blood from both mother and child. The child was healthy but was sampled since *Brucella* was detected in her mother. In 2013, one of the cases was reported as domestic and was a laboratory acquired infection where a student was infected in an educational setting while handling samples of *Brucella*.

In 2016, 19 cases were reported, countries of infection were: Iraq (8), Somalia (4), Syria (3), and Italy, Kenya, Russia, Turkey (1 case each). There were 10 female cases and 9 male cases.

Active surveillance

Animals

During 2016, 4,300 bovine serum or milk samples from 4,300 individual holdings were analysed for *B.*

abortus and 2,000 ovine and caprine serum samples from 418 individual holdings were analysed for *B. melitensis* within the active surveillance programme. All samples but one were negative. One sheep in one herd tested positive in the ovine surveillance. There were no clinical signs in this herd nor epidemiological links suggesting possible routes of introduction. Serological samples from ten animals in the herd were tested for *B. melitensis*, all with negative results and altogether infection was ruled out. All samples from serological testing prior to export and from bulls at semen collection centres were negative as well.

DISCUSSION

In summary, *Brucella* infection was not detected in cattle, sheep, goats or pigs during 2016. The long standing and extensive serological screenings performed without finding any infection and the very low number of human cases, only occasionally domestically acquired, confirms that *Brucella* is not present in Swedish food-producing animals. The enhanced passive surveillance in aborted foetuses from food-producing animals is an important part of the surveillance system.

An unknown number of stray dogs from countries where *B. canis* is endemic are brought into Sweden every year. It is important to be aware of the risk this group of dogs represents, for *Brucella* infection as well as for other diseases. Imported non-stray dogs, or dogs mated abroad are seen as a risk factor for introduction of *B. canis* into Sweden as well. During the past five years five dogs have tested positive for *B. canis* using bacterial culture and/or serology. All these dogs were imported or had close contact with imported dogs.

Campylobacteriosis

BACKGROUND

Thermophilic *Campylobacter* spp. are gram negative curved rods, and are the most common cause of human bacterial gastroenteritis in many countries. *Campylobacter* was first isolated from human diarrhoea in 1972, although spiral bacteria had earlier been seen microscopically in human stool samples. Most human infections are caused by *C. jejuni*, followed by *C. coli* and a few by other *Campylobacter* species.

Birds are considered the principal reservoir although *Campylobacter* can colonise the intestinal tract of many other animal species. The bacteria are excreted in faeces. *Campylobacter* spp. are fragile organisms but are able to survive in water for longer periods. The infectious dose for humans is low. A seasonal peak in the summer months is observed in most European countries. Most human infections are sporadic, which makes identification of the source of infection difficult in the absence of molecular typing. Risk factors for infection include consumption or handling of undercooked contaminated meat products (especially poultry), consuming contaminated unpasteurised milk and other dairy products, drinking from contaminated water supplies, travelling abroad and contact with farm animals and pets.

During the last two decades, the incidence of human campylobacteriosis has varied between 67 and 110 cases per 100,000 inhabitants (Figure 5). Of these, approximately 20-40% have been reported as domestic.

DISEASE

Animals

Asymptomatic carriage of thermophilic *Campylobacter* is common in several animal species.

Humans

Campylobacteriosis is an acute usually self-limiting enteric disease that resolves within a week. In some individuals, the symptoms may last longer. The symptoms are mild to severe: diarrhoea, fever, abdominal pain, nausea and malaise. The infection can be complicated by reactive arthritis, irritable bowel syndrome as well as the neurological disorder Guillain-Barré syndrome.

LEGISLATION

Animals

Thermophilic *Campylobacter* spp. are notifiable in broilers. In addition, *Campylobacter fetus* subsp. *venerealis*, which causes bovine genital campylobacteriosis, is notifiable in Sweden, according to SJVFS 2013:23.

Food

Detection of *Campylobacter* spp. in food is not notifiable.

Humans

Infection with *Campylobacter* is notifiable according to the Communicable Disease Act (SFS 2004:168 with the amendments of SFS 2013:634).

SURVEILLANCE

Animals

A monitoring programme for broilers has been operated by the Swedish Poultry Meat Association since 1991. The programme covers 99% of the broilers slaughtered in Sweden. Since 2006, sampling is performed by collecting intact caeca from 10 birds of every slaughter flock at the major abattoirs. The caeca are pooled into one composite sample per batch. Samples are analysed according to ISO 10272: 2014 part 1 and 2.

Food

No official surveillance programme exists. Sampling may begin performed by national and local authorities.

Humans

Surveillance in humans is passive.

RESULTS

Animals

In 2016, thermophilic *Campylobacter* spp. were detected in 678 (15.4%) of the 4,389 broiler batches tested at slaughter (Figure 6), which is a clear increase from previous years. This high prevalence has not been observed since the year of 2003. In January-May of 2016, the monthly prevalence of *Campylobacter* in chicken slaughter batches was low (0.5-4.5%), whereas in July-December, the monthly prevalence varied from 19.9% to 26.9%.

Food

The samples collected by local authorities were mostly taken as part of investigations of a complaint or a suspected food poisoning (60 of 72). None of these samples were positive for *Campylobacter*.

Humans

A total of 11,021 cases of campylobacteriosis were reported in 2016, which is more than ever previously reported. Of the reported cases, 61% (6,893 cases) were domestic. The incidence in domestic cases increased by 44% from the year before to 69.0/100,000 inhabitants, which is the highest incidence, and highest increase of incidence, since the infection was made notifiable in 1989.

In 2016, there were unusually many cases reported in January, which was a continuation of the increase that was observed at the end of 2015. Whole genome sequencing showed that the same genotypes of *Campylobacter* circulated in both humans and in chicken flocks at the same time during this winter peak as well as during a similar peak in the winter 2014/2015. This supports the hypothesis that domestically produced chicken was the cause of the increase during these two winters. In February to May 2016, the number of reported cases were low which coincided with a low prevalence in chicken slaughter batches. The incidence started to increase in June and July, and during August more cases were reported than ever before since campylobacteriosis was made notifiable. These spectacularly high numbers persisted in September, and although there was a decline in the number of cases during the last months of the year, the incidence was still high above average for the season.

Among the cases who acquired their infections in Sweden in 2016, the median age was 47 years with a spread from about one month to 98 years. The incidence was highest in adults above the age of 20. As usual, there were more men (54%) than women reported with campylobacteriosis. The incidence was slightly higher among men in all age groups.

Apart from the general increase in domestic cases, one known outbreak of campylobacteriosis occurred in 2016. In the end of January, 23 people in two groups fell sick after having stayed at a spa hotel. Smoked duck, which was served as a starter to both groups of people, was suspected to have caused the outbreak. This hypothesis could not be proven though, neither by an epidemiological study nor by microbiological testing of the meat.

DISCUSSION

During the last fifteen years, the number of reported human cases of campylobacteriosis has increased. The increase has been particularly noticeable for the domestic cases. Although most campylobacteriosis cases are considered sporadic, outbreaks do occur. This was noticed in 2012, when stored human isolates could be subtyped together with strains from suspected sources. The subtyping showed to be a useful tool in the outbreak identifications. Moreover, the large increase in human cases in the winter months during the last two years and its link to poultry shows that also national outbreaks of campylobacteriosis occur. The exceptional increase of domestic cases in 2016 was temporally associated with an increase in the prevalence of *Campylobacter* in broiler flocks. Subtyping of isolates from humans and chicken is being conducted in order to confirm the temporal association.

In 2016, prevalence of *Campylobacter* in broiler batches was higher than for many years. From 2000 to 2005, the prevalence of *Campylobacter* in broiler flocks decreased from approximately 20% to 12-13%. In 2013, the percentage of *Campylobacter* positive broiler flocks was 8.8% which is the lowest reported (Figure 6). Since then, the prevalence has been increasing which is worrying. However, prevalence varies considerably between slaughterhouses, with only a few findings at some abattoirs and high prevalences at others. Chicken production has increased in Sweden and the industry has started to apply practises that increased the prevalence of *Campylobacter* infected broiler flocks.

The increase in domestic cases was most likely due to a corresponding increase in the proportion of *Campylobacter* infected poultry flocks from one of the major slaughterhouses. This could, in turn, be explained by the production being put under heavy pressure because of an increased demand for chicken meat by the consumers.

Reducing *Campylobacter* prevalence at the farm level decreases the risk of human infection. Over the years, applying strict biosecurity measures has decreased the number of *Campylobacter* positive broiler slaughter batches in Sweden. However, there has been a marked change in the production system and currently, more effort is needed to decrease the number of infected broiler flocks. Carcasses are easily contaminated at slaughter and at secondary processing which necessitates the application of good

hygiene practices. Also, freezing *Campylobacter* positive carcasses or scheduling them for heat-treatment would reduce the risk to consumers.

Strict hygiene in the kitchen is essential to avoid cross-contamination between contaminated food and food that will not be heated such as raw vegetables. Likewise good hygiene is important when preparing food for social gatherings.

In order to decrease human incidence of campylobacteriosis, a national strategy plan for *Campylobacter* has been prepared and published 2013 in cooperation between the Swedish Board of Agriculture, National Food Agency, Public Health Agency of Sweden, the National Board of Health and Welfare and the National Veterinary Institute. Several measures to control the infection were proposed in the strategy document which is now scheduled for revision in 2017.

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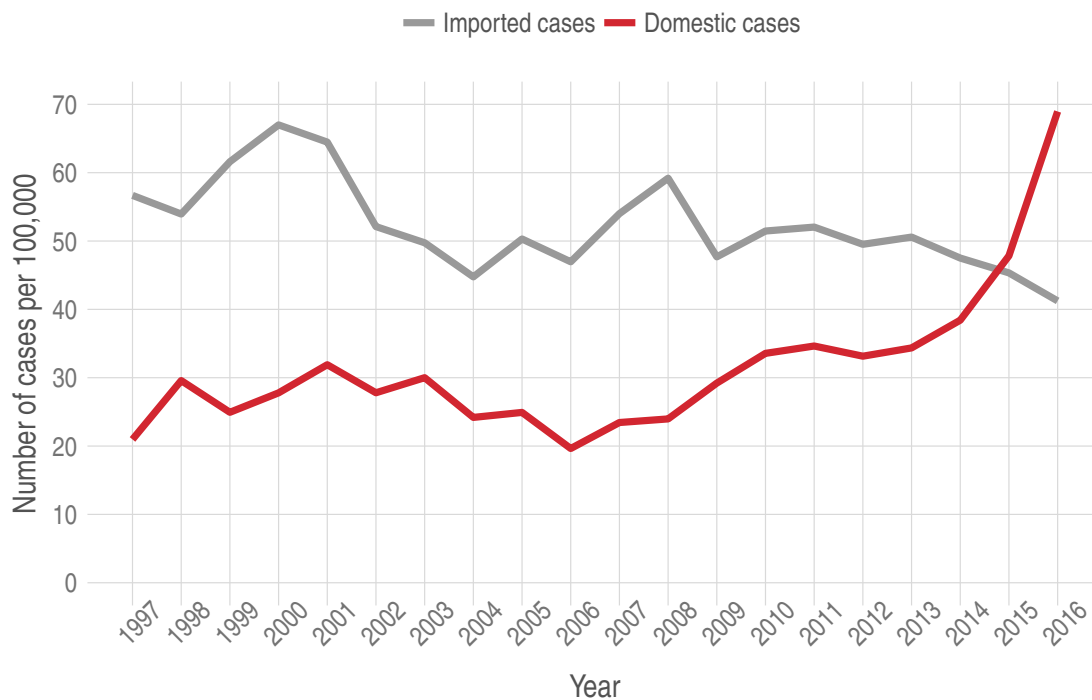


Figure 5: Notified incidence (per 100,000 inhabitants) of human cases of campylobacteriosis in Sweden, 1997-2016. Imported cases are those where the patient has reported travel to another country during the incubation period prior to clinical presentation. Domestic cases are patients that have not recently travelled outside Sweden.

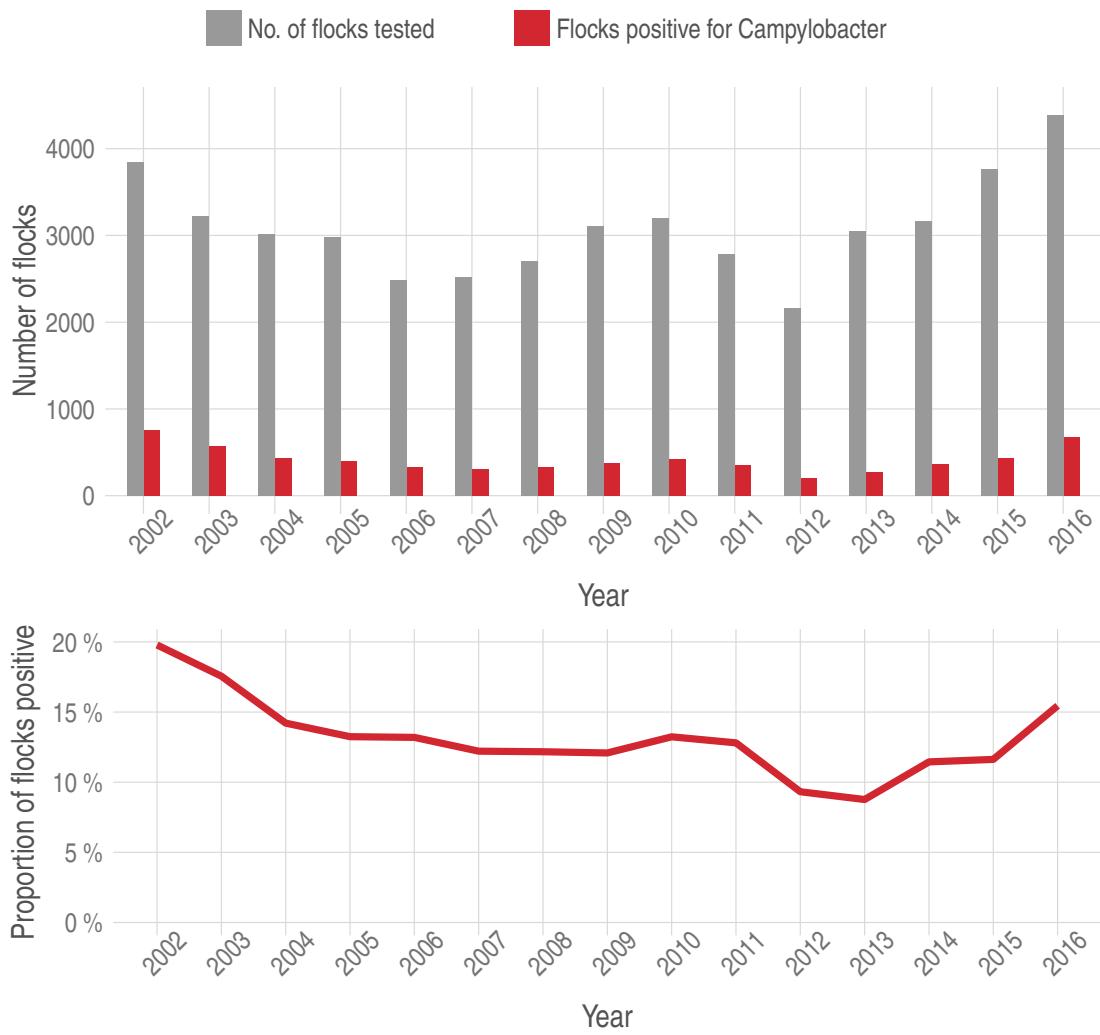


Figure 6: Prevalence of *Campylobacter* in broiler flocks in 2002-2016.

Chronic wasting disease

BACKGROUND

Chronic wasting disease (CWD) is a transmissible spongiform encephalopathy (TSE) affecting cervid species. The disease was first described in Colorado in 1967 and in 1978 identified as a transmissible spongiform encephalopathy (TSE). The disease has spread, and is now confirmed present in more than twenty states in the USA, and in two Canadian provinces (CDC, 2017). Through export of live cervids, CWD has also been exported to South Korea.

The currently accepted theory of TSEs is that they are transmitted through small proteins, prions with abnormal structural conformation. These prions induce a structural transformation of normal prion-proteins in the body of the recipient. Thus, the disease is not caused by parasites, bacteria, fungi or viruses, but by proteins. The full details of these processes are not yet understood. Prions accumulate in body tissues, especially the brain where damage can be observed. Although TSEs exist in other ruminant species, i.e. bovine spongiform encephalopathy (BSE) in cattle and Scrapie in sheep and goats, there are essential differences when it comes to spread of disease and distribution of prions in the body. Spontaneous cases of TSEs seem to occur both in human and animals.

Due to similarities with BSE, which is linked to variant Creutzfeldt Jacobs disease in humans, and the known fact that many transmissible spongiform encephalopathies experimentally can be transmitted between several different species, there has been a suspicion that Chronic Wasting Disease may be a zoonotic disease. Currently, there is not enough data to exclude that CWD could be zoonotic, however, the risk is deemed to be very low (VMK 2016, Wadell 2017). In areas where CWD is endemic, people are recommended not to consume animals displaying clinical signs consistent with CWD or animals with positive test results for CWD.

Until 2016, CWD had not been reported in Europe. But in spring of 2016, the first case in Europe was detected in wild reindeer in the region of Nordfjella in Norway (Benestad *et al*, 2016). As a consequence of the finding, surveillance in Norway was intensified and this resulted in the detection of the disease in two moose close to the Swedish border and detection of two further cases in the reindeer

flock of Nordfjella. The cases in reindeer show similarities with the cases found in North America. The origin of the outbreaks has not been confirmed.

Wildlife, including cervid animals, cross the border between Sweden and Norway. Some semidomesticated reindeer also cross the border between the countries. In Sweden, reindeer herding is an essential part of the Sami culture; there are no wild reindeer and only Sami people have the rights of reindeer husbandry. Moose and roe deer live in the wild (with few exceptions) and many people are involved in hunting of these species. The farmed cervid species in Sweden are mainly fallow deer and red deer, as well as a small number of moose.



Photo: Stefan Ljunggren

HISTORY

At the time of writing, the disease has not been detected in Sweden (May 2017). However, with exception of an EU-regulated active surveillance in 2007-2010, surveillance has only been passive, i.e. based on reporting of animals displaying clinical signs. Since the disease has not been known to occur in Europe, the awareness of the disease in the field has been low and as a consequence very few animals have been examined.

DISEASE

The incubation period is long, over a year. The disease spreads through direct contact between animals but also through body excretions which can contaminate the environment. The predominant clinical signs are behavioural changes, change of locomotion and loss of body condition. The disease is fatal.

LEGISLATION

CWD is a notifiable disease under the Swedish Act of Epizootic diseases (SFS 1999:657, with amendments) and there is a scheme to compensate farmers for losses due to eradication measures. To a certain extent, CWD is also regulated through the Regulation (EC) No 999/2001 of the European Parliament and of the Council of 22 May 2001.

SURVEILLANCE

As mentioned above, CWD is a notifiable disease. However, as the disease has not been known to be present in Europe, the awareness of the disease has been low and very few suspect cases have been reported. In response to the detection of CWD in Norway, information was sent to stakeholder organisations encouraging them to be observant and notify animals displaying clinical signs of CWD.

General sampling of all adult cervids sent for necropsy to SVA started during summer 2016. Moreover, a retrospective CWD study was conducted in the autumn of 2016 examining frozen brain from cervids sent for necropsy between 2008–first part of 2016. Brainstem samples were analysed with Bio-Rad TeSeE short assay protocol (SAP) at the National Veterinary Institute which is the National Reference Laboratory (Regulation (EC) 999/2001) for TSEs.

RESULTS

From the summer of 2016, 96 cervids (74 moose, 14 roe deer, 6 red deer and 2 reindeer) were examined for CWD at SVA, all with negative results. In the retrospective study performed during 2016, the 270 cervids investigated were also all negative for CWD.

DISCUSSION

The number of animals examined is so far has been limited and not well represented geographically, the current status in the country is therefore largely unknown. It cannot be excluded that the disease is present in Sweden. Large scale surveillance, ensuring geographical coverage and ensuring inclusion of populations with potential contact with the populations in Norway where the disease has been detected is needed. Planning has started and Sweden is currently awaiting a decision from the European Commission which will set the minimum level of surveillance required.

If the disease is present or introduced in the country, it could have large consequences for reindeer, wild cervid populations and farmed cervids. Consequently, the disease could also have large consequences for people involved in activities related to these species or making their living from these species.

The experience from North America is that CWD is very difficult to eradicate, and to have a chance, early detection is needed while the prevalence is still low.

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Classical swine fever



Photo: Marie Sjölund

BACKGROUND

Classical swine fever (CSF) is a disease of pigs caused by a pestivirus closely related to bovine virus diarrhoea virus and border disease virus. The acute clinical form of CSF cannot be distinguished from the clinical manifestation of African swine fever (ASF), although these two viruses are not related. CSF is considered one of the most important and devastating pig diseases worldwide. During 1997-98 an extensive outbreak occurred in the Netherlands, Germany, Belgium and Spain. Since then, outbreaks in Europe have been confined to more limited geographic regions although the outbreaks in Lithuania 2009 and 2011 involved very large farms and are thus considered extensive. In 2012 and 2014 CSF was reported in domestic pigs in Latvia and was still present in the wild boar population there during 2015. Ukraine recently reported CSF in wild boar and CSFV is also present in Russia as well as in Asia and South America. CSF has not been diagnosed in Sweden since 1944 and Sweden received official status as a historically CSF free

country in February 2015.

Classical swine fever is a highly contagious disease that is transmitted by direct and indirect contact between animals. Feeding pigs swill contaminated with CSFV is considered the main route of spreading the disease to new areas. Because of this, swill feeding of pigs is prohibited in the European Union.

DISEASE

CSF appears in different clinical forms; acute, chronic and a mild form with reproductive disorders as the main clinical manifestation. The incubation period is 2-14 days and the acute form of the disease includes high fever ($<42^{\circ}\text{C}$), shivering, weak hind legs, purple discolouring of the skin and diarrhoea. Chronically infected animals exhibit a more diffuse clinical picture with intermittent fever, anorexia and stunted growth. In the mild form, abortion is the main clinical sign.

LEGISLATION

CSF is included in the Swedish Act of Epizootic diseases (SFS 1999:657 with amendments) and the control of the disease is regulated in detail through EU directives.

SURVEILLANCE

The purpose of the surveillance programme is to document freedom from CSF in the Swedish pig population and to contribute to the maintenance of this situation by early detection of an introduction. The National Veterinary Institute is responsible for selection of samples, sample analysis and reporting to the Swedish Board of Agriculture. The serological analyses for CSF, PCR-analyses for the presence of CSF viral genome and CSFV culturing are performed at the National Veterinary Institute. CSF serology is done using a commercial kit (IDEXX® HerdChek CSFV Antibody Test Kit) and in case of positive ELISA results, a confirming serum neutralisation (SN) test for detection of antibodies against CSFV is performed.

Passive surveillance

Because CSF is notifiable on clinical suspicion for both veterinarians and farmers, cases with clinical signs consistent with CSF will be investigated following a notification to the Swedish Board of Agriculture. The investigation includes restrictions on the farm during investigation, sampling of sick or dead animals and examination of the herd for presence of clinical signs and analyses of production results. Due to the similarity of clinical signs, samples are analysed for both CSF and ASF. This strategy is strongly recommended by the EU.

In addition, analyses for the CSFV genome with PCR are included in the enhanced passive surveillance of aborted fetuses (Page 129).

Active surveillance

Samples collected for the abattoir sampling part of the surveillance carried out by the Farm & Animal Health for porcine reproductive and respiratory syndrome (PRRS) were used for the active surveillance. See chapter on PRRS for details on sampling and population. The surveillance was designed using a design prevalence of 0.5% between herd, 40%

within herd, and a risk of introduction of 1 in 25 years.

In addition to the surveillance of CSF in domestic pigs there is also an active surveillance of CSF in wild boar (Page 122)

RESULTS

Passive surveillance

Five investigations following clinical suspicion of CSF were carried out during 2016. The clinical manifestations included reproductive failure, high piglet mortality and circulatory disorders in sows. Following further investigations, including sampling, the herds could be declared negative for CSF (the investigations also included testing for either or all of PRRS, Aujeszky's disease and African swine fever).

Within the surveillance of aborted fetuses, 43 fetuses from 23 herds were examined for the CSF viral genome and all samples were negative.

Active surveillance

Serum samples from 2,000 pigs were analysed and in none of them antibodies to CSFV could be found. Taking the surveillance outcome from 2015 into account, the probability of freedom based on the summarised surveillance during 2016, was >99%.

DISCUSSION

The results from the passive and active surveillance for CSF in Sweden during 2016 add to the documentation of freedom from this infection in the Swedish commercial pig population. During recent years the Swedish pig industry has undergone heavy structural changes leading to a rapidly declining number of herds and extensive changes in the market and in the habits of farmers. The active surveillance, in terms of planning design and number of samples, is therefore evaluated yearly and adjusted accordingly if needed.

Although the situation regarding CSF in the EU has been continuously improved in recent years, occasional outbreaks in domestic pigs in countries close to Sweden and the extensive movement of products and people, including labour in the animal production sector, emphasises the need for both passive and active surveillance for CSF.

Coccidiosis and clostridiosis

BACKGROUND

Coccidiosis and clostridiosis are intestinal diseases that commonly affect broiler chickens worldwide. Both diseases are major causes of economic losses and reduced welfare.

DISEASE

Coccidiosis is caused by microscopic parasites (genus *Eimeria*) that invade the intestinal epithelium. *Eimeria spp.* are ubiquitous, resilient and host specific parasites that are easily transmitted between birds by the faecal-oral route, especially when birds are kept on litter at a high stocking density. The severity of the intestinal lesions is influenced by parasite and host factors, such as parasite species, infectious dose, host age and level of immunity. Generally, young broiler chickens are highly susceptible.

Clostridiosis is a multifactorial disease and the pathogenesis is not well understood. Clostridiosis is associated with proliferation of the bacterium *Clostridium perfringens* type A, which together with management factors and loss of mucosal integrity cause lesions in the intestines (necrotic enteritis) and liver (cholangiohepatitis).

Clinical signs of coccidiosis and clostridiosis range from clinical disease with significantly increased mortality rates to mild or subclinical forms, which are associated with reduced weight gain and impaired feed conversion. Clostridiosis is also a cause of condemnation at slaughter due to liver lesions. Both diseases may be prevented by in-feed ionophorous anticoccidials.

LEGISLATION

The health control programme for coccidiosis and clostridiosis in broilers is regulated in Swedish legislation (SJVFS 1998:131) and is administered by the Swedish Poultry Meat Association.

SURVEILLANCE

The purpose of the surveillance is to document that the anticoccidials efficiently protect broilers from disease and to monitor the amount anticoccidials used. The longterm goal is to replace anticoccidials by other preventive measures.

Field control of anticoccidial efficacy is performed by a lesion scoring method in broiler chickens from selected farms. If the lesion score of an individual flock exceeds a certain level (2.5) an analysis of the feed for the concentration of anticoccidial is performed and an on-farm investigation of management and general health status is carried out. The occurrence of hepatic and intestinal lesions is monitored at the abattoir, and if more than 0.5% of the birds in a flock are affected samples are sent for histological examination to the National Veterinary Institute. Further, data are compiled on a quarterly basis from all abattoirs on the overall level of condemnations due to liver lesions.

RESULTS AND DISCUSSION

In 2016, a lesion score (MTLS/Mean Total Lesion Score) of > 2.5 of 16 investigated broiler flocks was not found except in one case (2.6). According to the sampler the reason was that the owner has given the broilers Narasin free feed (end feed) during a couple of days.

Samples for histological examination of the liver and intestine were submitted from abattoirs from 58 broiler flocks with > 0.5% condemnation due to liver and/or intestine lesions. Lesions consistent with clostridiosis (i.e. cholangiohepatitis) were observed in all flocks.

It was concluded that there is currently no indication of reduced efficacy of anticoccidials in Sweden, despite the increasing occurrence of hepatic lesions at the abattoirs. No longterm trends towards reduced anticoccidial efficacy or increased prevalence of coccidiosis were observed.

During 2016, the Animal Health Board who is responsible for this program has reviewed and assessed this control program and proposed that no essential changes in the program are needed.

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Echinococcosis



Photo: Karin Bernodt

BACKGROUND

Echinococcosis is a common name for different diseases in humans caused by tapeworms belonging to the genus *Echinococcus*. Although the genus contains several species, only the species of *E. granulosus* and *multilocularis* exist in Europe. The life cycles of these parasites are completely different but both require two hosts: a definitive and an intermediate host. Humans are dead-end hosts of these parasites and may become infected by accidental ingestion of the eggs.

Alveolar echinococcosis

BACKGROUND

Echinococcus multilocularis is endemic in large parts of Europe and has a reported increasing geographical range. Although a rare disease in humans, alveolar echinococcosis is of considerable public health concern due to its high mortality if untreated as well as high treatment costs. The definitive hosts of this parasite are mainly foxes, but raccoon dogs, dogs, coyotes and wolves can also act as definitive hosts. Rodents, mainly voles, serve as intermediate hosts. Foxes contract *E. multilocularis* by eating infected rodents.

HISTORY

Prior to 2010, *E. multilocularis* had not been detected, and no case of alveolar echinococcosis had been reported in Sweden. As a response to finding *E. multilocularis* in foxes in Denmark, an active monitoring programme of the red fox (*Vulpes vulpes*) was implemented in Sweden in 2000. From 2000 to 2009, a total of 2962 red foxes, 68 raccoon dogs (*Nyctereutes procyonoides*) and 35 wolves (*Canis lupus*) were examined for *E. multilocularis*, all with negative results. Samples from the majority of foxes ($n=2,675$) were examined by ELISA (CoproAntigen ELISA) at the Institute for Parasitology, Zurich University, for the presence of the *E. multilocularis* coproantigen. The remaining samples and

those that were ELISA-positive, were examined using the sedimentation and counting technique (SCT) ($n=726$). All samples from raccoon dogs and wolves were examined by SCT.

During 2010, 304 foxes were examined for *E. multilocularis*. A total of 103 were tested by SCT and 201 by egg-PCR. One fox, shot in south-west Sweden (Västra Götaland) and analysed in 2011 was found to be positive.

During the spring of 2011, a national surveillance programme was implemented where 2,985 hunter-shot foxes were analysed with the segmental sedimentation and counting technique (SSCT). Three foxes were found positive: one in Västra Götaland, one in Södermanland and one in Dalarna County. In addition, 119 faecal samples from hunting dogs collected in the region of the first positive finding were analysed with egg-PCR and all were negative. In the same area 236 rodents were necropsied and all potential lesions examined by an in-house PCR without any positive finding.

To obtain a better prevalence estimate in a known infected area, fox scats were collected, by a systematic sampling procedure, from an area of 25 km surrounding a positive finding in Södermanland County during 2011 and analysed in 2012 using semi-automated magnetic capture probe based DNA extraction and real-time PCR method (MC-PCR). Six out of 790 (0.8%) faecal samples were positive.

A second national screening was initiated in 2012 and continued in 2013 and 2014. In all, a total of 2,779 fox scat samples were analysed and three positive fox scats were identified, one from Gnesta, one from Katrineholm (both in the county of Södermanland) and one from the county of Västra Götaland.

From the five known infected areas, hunters were asked to submit 30 foxes from each circular area with a diameter of 40 km. The aim was to follow up the positive findings, and to collect parasites from any positive cases, for further subtyping. Sampling was initiated in 2012. In four of five areas this sampling was finalised, whereas in one area (Gnesta) only 15 foxes were submitted in time for testing. In Västra Götaland two foxes were positive, in Södermanland two foxes from Katrineholm and one from Gnesta were positive, whereas no foxes from Dalarna or Kronoberg were positive.

Within the Emiro research project (<http://www.emiro.org/>) and the FoMA Zoonosis monitoring programme (<http://www.slu.se/en/>

environment) at the Swedish University of Agricultural Sciences (SLU) finalized in 2016, the parasite was found for the first time in an intermediate host, voles caught in Södermanlands county in 2013 (Gnesta/Nyköping). One out of 187 *Microtus agrestis* and eight out of 439 *Arvicola amphibius* were positive. Presence of protoscolexes were confirmed in the infected *Microtus agrestis* and in three out of eight *Arvicola amphibius*. No lesions were found in *Myodes glareolus* ($n=655$) and *Apodemus* spp. ($n=285$). Within this project a new infected area was identified, Västmanland region in Kronoberg County in 2014.

In 2012, alveolar echinococcosis was diagnosed in humans in Sweden for the first time. There were two human cases with clinical symptoms and both were considered to have been infected abroad. No human cases were diagnosed in 2013 to 2015.

DISEASE

Animals

In the definitive animal host, the infection is asymptomatic. The main intermediate hosts, rodents, will usually die from the infection if not captured by a predator.

Humans

In humans, alveolar echinococcosis may develop into a serious, potentially fatal disease characterised by infiltrative tumour-like lesions in the affected organ. The incubation period for developing alveolar echinococcosis in humans is assumed to be between 5 and 15 years. Because of the long incubation period, the disease is most frequently seen in adults. The most common site of localisation is the liver but other organs can also be affected. Symptoms depend on the site and size of the lesion.

LEGISLATION

Animals

Detection of the parasite is notifiable according to Swedish legislation (SJVFS 2013:23). Until December 31, 2011, all imported dogs and cats (except from certain countries) were required to be dewormed with praziquantel before entering Sweden as a preventive measure. Because *E. multilocularis* has been detected in Sweden, there is presently no legal requirement to deworm pets entering the country. However, as the prevalence of the parasite in foxes is very low in Sweden compared to many European countries, dog owners are still encouraged to deworm their dogs prior to entry to Sweden.

Humans

Infection with *Echinococcus spp.* has been notifiable since 2004 according to the Communicable Disease Act (SFS 2004:168) with the amendments of SFS 2013:634. However, notification at the species level is not required. If cases of *E. multilocularis* occur in humans, the data will be presented in the annual report at the website of the Public Health Agency of Sweden (<http://www.folkhalsomyndigheten.se>). Before 2004, *Echinococcus spp.* was reported on a voluntary basis by the laboratories.

SURVEILLANCE

Animals

As *E. multilocularis* does not cause clinical signs in the definitive host, effective monitoring in these species must be active.

From one infected area, Gnesta (Södermanland County), sampling continued during the fox hunting season in 2016, where hunters had been asked to submit 30 foxes from each area. The foxes were tested with MC-PCR and positive foxes were further investigated with SSCT.

All free-living wolves submitted to necropsy at the National Veterinary Institute were tested with MC-PCR.

Humans

Surveillance in humans is passive.

RESULTS

Animals

In the sampling of foxes from one infected area (Gnesta), to obtain material for further subtyping, 11 foxes were analysed during 2016. None of the examined foxes were positive for *E. multilocularis*.

During 2016, 40 wolves (*Canis lupus lupus*) and one wolf scat, one red fox and five dogs were tested with the MC-PCR and all were negative. In the 2015 report, results of MC-PCR from 11 raccoon dogs and SSCT from three wolves were pending. These analysis were finalized during 2016 and all were negative.

Humans

In 2016, there was one case of alveolar echinococcosis reported, who had acquired the infection in his country of origin, Lithuania.

DISCUSSION

E. multilocularis is considered to be endemic albeit at a very low prevalence in Sweden. It is not known if, and in that case, when the parasite was introduced into the country. The national screening finalised in 2014 has described the present national prevalence and can be used as a baseline. If national screenings are repeated with, for example, 5 or 10 years intervals this will clarify if the prevalence changes over time. It is well known that the prevalence of this parasite varies geographically. Regional screenings have earlier shown a prevalence of more than 1% in a part of Södermanlands County and within the Emiro research project and FoMA Zoonosis monitoring programme at the Swedish University of Agricultural Sciences (SLU) 18 of 80 (20%) of fox scats was found in one of four investigated small areas. Based on earlier findings it has been concluded that the parasite is endemic in the country, however the true geographical distribution is unknown. No positive cases have been found north of Dalarna County. At present, a total of five areas have been found infected within the surveillance programs and the Emiro research project. If monitoring continues it is probable that new infected areas will continue to be detected.

E. multilocularis was found for the first time in an intermediate host in 2014, within the Emiro research project. This finding increases our knowledge about in which biotypes the life cycle of the parasite can be completed. It was suggested that the absence of *Microtus Arvalis* in Sweden may be a contributing factor to the low prevalence of the parasite found in Sweden. However, in small restricted areas, prevalence has been reported to be higher and more research is needed to clarify which intermediate host(s) are most important.

Based on the studies that exist today, the risk that humans will become infected in Sweden is considered negligible.

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Cystic echinococcosis

BACKGROUND

Cystic echinococcosis is caused by *Echinococcus granulosus*. Domestic dogs and wolves are the most frequent main hosts. Eggs of the parasite are excreted in faeces into the environment where they can infect intermediate hosts such as cattle, horses and wild ruminants. The eggs develop into the larval stage (hydatid cyst) mainly in the liver and occasionally in other organs of the intermediate host. The main hosts get the infection when consuming organs containing larval cysts.

History

Echinococcosis was quite common in reindeer in the northern parts of Scandinavia in the first half of the 20th century. In the 1990's single cases of *E. granulosus* were detected in moose and reindeer in Sweden.

DISEASE

Animals

In animals, the infection is usually asymptomatic.

Humans

In humans, the main site of localisation of cystic echinococcosis is the liver. However, the lungs, brain or other tissues may also be involved. Infected patients may remain asymptomatic for years or permanently. Clinical signs of disease depend on the number of cysts, their size, localisation and pressure exerted on surrounding organs or tissues. The incubation period for developing cystic echinococcosis ranges from one to several years.

LEGISLATION

Animals

Detection of the parasite is notifiable in all animals according to (SJVFS 2013:23).

Humans

Echinococcosis has been notifiable according to the Communicable Disease Act since 2004 (SFS 2004:168) with the amendments of SFS 2013:634. However, notification on species level is not required. If cases of *E. multilocularis* occur in humans the data will be presented in the annual report at the website of the Public Health Agency of Sweden (<http://www.folkhalsomyndigheten.se>). Before 2004 *Echinococcus* spp. was voluntarily reported by the laboratories.

SURVEILLANCE

Animals

All animals are inspected for cysts during routine meat inspection. Semi-domesticated reindeer are inspected at slaughter, but not all free-ranging hunted cervids are inspected. If cysts are noted in liver or lung, samples would in some, but not all cases, be sent to the National Veterinary Institute for diagnosis. All free-living wolves submitted to necropsy at SVA are analysed with semi-automated magnetic capture probe based DNA extraction and real-time PCR method (MC-PCR).

Humans

Surveillance in humans is passive.

RESULTS

Animals

During 2016, 40 wolves submitted for necropsy and one wolf scat were MC-PCR-tested; all were negative. During the slaughter season of 2015-2016, 54,745 reindeer were slaughtered and inspected. The statistics for the 2016-2017 season are not yet available. *E. granulosus* was not detected in any animals in 2016.

Humans

In 2016, 26 cases of cystic echinococcosis were reported. Annually around 15-30 cases are reported in Sweden. In 2016, the reported cases ranged in age from 5 to 87 years (median 39 years). Twelve cases were women and 14 were men. They were all considered to have been infected abroad in areas where the parasite is endemic and the most frequently specified countries of infection were Syria (11 cases) and Iraq (5 cases).

DISCUSSION

E. granulosus has not been detected in Sweden in animals since the late 1990s, when it was reported in two reindeer in the northernmost regions of Sweden, bordering Norway and Finland. The parasite is

prevalent in several European countries. In Finland it has occurred in wildlife (wolves, moose and reindeer). In other European countries it is identified mainly in a cycle between dogs and farm animals.

In humans, cystic echinococcosis is a rare disease seen in immigrants or other people who have resided in endemic countries. In Sweden, no domestically acquired human cases have been reported since the infection became notifiable. In Finland, on the other hand, pulmonary cystic echinococcosis (*Echinococcus canadensis*) was confirmed in 2015 in an eight year old child from the eastern parts of the country with no history of travelling abroad. The infection was presumably transmitted by hunting dogs.

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Enzootic bovine leucosis

BACKGROUND

Enzootic bovine leucosis (EBL) is caused by bovine leukaemia virus, which is an oncovirus in the family Retroviridae. The viral infection is transmitted by infected lymphocytes via contact with contaminated biological material from an infected animal. Sweden was declared officially free from EBL by the European Union (EU) in January 2001 (former Decision 2001/28/EC, currently Decision 2003/467/EC last amended by Decision 2005/764/ EC). Before this, a voluntary control programme had started in 1990 and a mandatory eradication programme had been running since the autumn of 1995.

DISEASE

EBL is characterized by multiple cases of multicentric lymphosarcoma in adult cattle within a herd after an incubation period of 4-5 years. The tumours can develop rapidly in many sites, which may cause variable clinical signs depending on the site. Persistent lymphocytosis, without clinical signs, develops earlier but rarely before 2 years of age.

LEGISLATION

EBL is included in the Swedish legislation for notifiable diseases (SJVFS 2013:23). EBL is also on the OIE list of infectious diseases and current surveillance standards are given in EU legislation, Directive 64/432/EEC.

SURVEILLANCE

The purpose of the surveillance is to document freedom from EBL in accordance with Directive 64/432/EEC. Växa Sverige (former Swedish Dairy Association) is responsible for this surveillance, which is financed by the Swedish Board of Agriculture.

From 2010 onwards, surveillance in dairy herds has been performed by random sampling. The between-herd design prevalence is 0.2% and the within-herd design prevalence 15%, with a 99% confidence, given known freedom of infection the previous year. To achieve this, approximately 1,500 herds need to be randomly sampled per year. Bulk milk samples are collected within the quality control programmes of the dairies. The surveillance in beef herds is performed with an aim to random sample 1-3 animals per herd in 2,000 herds every year. Serum is collected from slaughtered cattle above 2 years of age originating from sampled herds. Details on numbers of herds and animals tested in 2016 are given in Table 5.

Diagnostic testing is performed at the National Veterinary Institute. Both milk and sera are analyzed using an antibody ELISA (Svanovir® BLV GP-51 ELISA).

RESULTS

No positive samples were found in 2016.

DISCUSSION

Sweden was declared free from EBL in 2001 (Commission Decision 2001/28 EC), and has had a very stable disease-free situation since then. In 2012 one slaughtered animal above 2 years of age was positive for EBL. All animals over 6 months in the herd from which the positive animal originated were tested for EBL in spring 2013 and all samples were negative. The herd was thereafter cleared from suspicions of EBL infection.

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Table 5: Total numbers of herds and animals tested for EBL antibodies in 2016.

Herd type (sample type)	Herds	Animals
Dairy herds (1 bulk milk sample per herd)	1,447	-
Beef herds (blood from 1-3 animals per herd)	1,741	4,396
Beef herds with three animals tested	645	-
Beef herds with two tested animals	387	-
Beef herds with one tested animal	709	-

Footrot



Photo: SVA

BACKGROUND

Footrot is a globally distributed contagious disease in sheep and goats. The causative agent is *Dichelobacter nodosus* (*D. nodosus*). The disease is characterised by inter-digital dermatitis, and predisposing factors are humid and warm weather conditions. The severity of footrot can vary by the strain of *D. nodosus* and the environmental conditions.

The first case of footrot in Swedish sheep was identified in 2004. Data on all affected flocks have been recorded since 2004. A study on the prevalence in slaughter lambs was performed in 2009 and a voluntary control programme for footrot (“Klövkontrollen”) was established by Farm & Animal Health in 2009.

DISEASE

The clinical signs of the disease are typically foot lesions, and lameness due to the painful lesions. However, lameness is not a consistent clinical sign in all affected sheep. Footrot varies greatly in severity from inflammation of the interdigital skin to complete underrunning of hoof horn.

LEGISLATION

Footrot is a notifiable disease (SJVFS 2013:23).

SURVEILLANCE

The aim of the control programme is to eliminate footrot from affected sheep flocks and to provide certification of freedom from footrot for the sheep trade. Another important part of the programme is training of veterinarians and non-veterinary staff to perform clinical inspection and footrot scoring. The feet of sheep are inspected by veterinarians and farmers on an annual basis. The inspections are performed during August 15 to October 15, when the risk of footrot is highest due to the weather conditions. If no signs of footrot are detected, the flock is certified free from footrot (F-status). However, if signs of footrot are documented the following measures are taken: foot baths, moving of animals to clean pasture and culling of chronically infected sheep. Flocks with a history of footrot can be certified as free, at the earliest ten months after the last signs of infection.

Diagnostic testing of samples from interdigital

skin is performed at the National Veterinary Institute. The development of additional diagnostic tools is also linked to the control programme. Recent improvements to the programme include testing of strains for virulence and pooling of samples. A total of 355 sheep flocks are affiliated to the control programme.

For all newly affiliated flocks and for all flocks where footrot is suspected at the first contact, a new PCR (Frosth et al 2015) is used for detecting *D. nodosus* and determining strain virulence.

RESULTS

During 2016, 10 flocks were detected with footrot, compared to 47 flocks during 2007 (Figure 7). In 2 of the 10 flocks, virulent strains of *D. nodosus* were detected. In the programme, 346 flocks were certified free from footrot (F-status). Most of the Swedish *D. nodosus* strains are benign, and the virulent type is uncommon (S. Frosth 2016).

DISCUSSION

The awareness of disease control has been enhanced in the sheep farming community, and their agreement on a trade ban between certified and non-certified flocks has been essential to the programme's

success. Good collaboration between authorities, the sheep farming community and individual sheep farmers has resulted in a cost-effective control programme.

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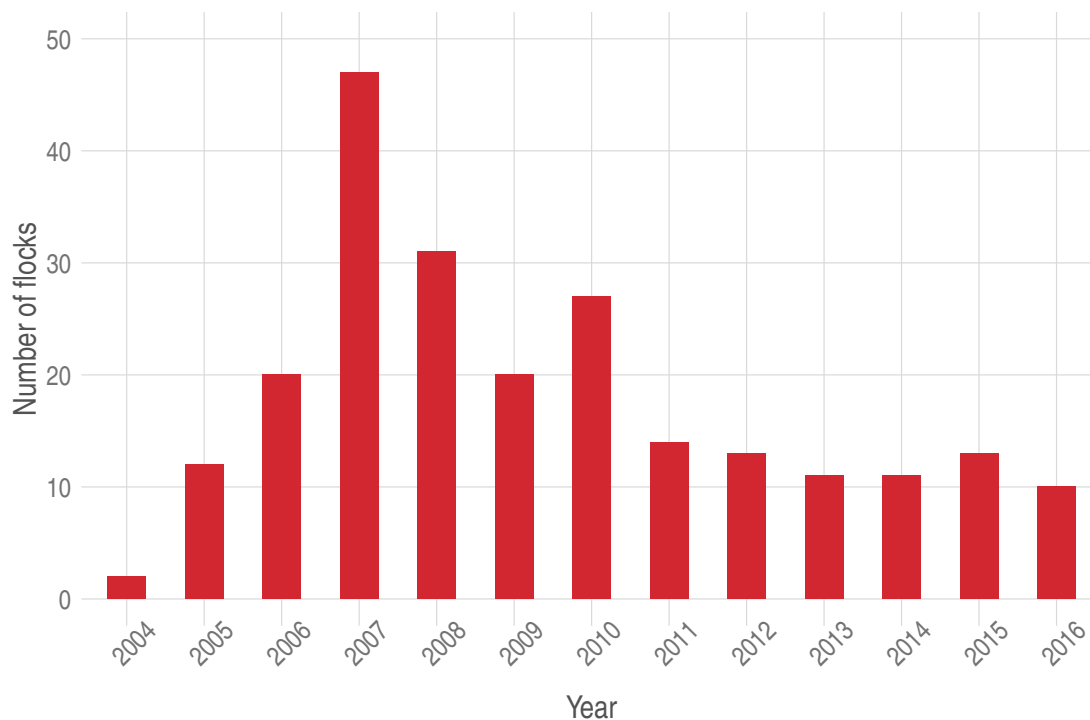


Figure 7: Number of sheep flocks detected with footrot 2004-2016

Infectious bovine rhinotracheitis

BACKGROUND

Infectious bovine rhinotracheitis (IBR) is caused by Bovine herpes virus 1. The same virus can affect different organ systems causing respiratory, abortive, genital or conjunctival disease. Transmission is mainly by aerosol for the respiratory form and by venereal transmission for the genital form.

Examination of Swedish bulk milk samples during the early nineties showed the presence of a small number of seropositive herds. No signs of clinical disease were present in these herds. An eradication programme was initiated in 1994 and the last seropositive animal was found in 1995.

DISEASE

The incubation period of IBR is 3-21 days, but the virus can be silently present in the host animal and be reactivated by stress or immunosuppression. The clinical picture varies by subtype of the virus but also with the environmental and management factors. Several manifestations of the disease can be present during the same outbreak in the same herd. However, the clinical signs are typically concentrated either to the respiratory tract, reproductive organs or the eyes.

LEGISLATION

The Swedish IBR eradication programme was approved in 1994 (Decision 73/94/ COL and Decision 95/71/EC). Sweden was allowed additional guarantees by the EU to reduce the chance of IBR introduction in 1995 (Decision 95/109/EC) and was officially declared free from IBR in 1998 (former Decision 98/362/ EC, current Decision 2004/558/ EC). Since 2004, all neighbouring Nordic countries have additional guarantees from the EU relating to this disease (Decision 74/94/ COL and Decision 95/71/EC). IBR is included in the Swedish Act of Epizootic diseases (SFS 1999:657 with amendments). Vaccination is prohibited and notification of clinical suspicion is mandatory.

SURVEILLANCE

All diagnostic testing was performed at the National Veterinary Institute. Milk and sera were analysed for the presence of antibodies using an indirect ELISA (SVANOVIR™ IBRab, Svanova®). A blocking-ELISA IBR/BHV-1 gB Ab ELISA kit

(IDEXX) was used for confirmatory testing. Semen and organ samples were tested with a real time PCR. A positive case is defined as an animal with a positive PCR result or a confirmed positive serological reaction for IBR.

Passive surveillance

Suspicious based on clinical signs must be reported to the Swedish Board of Agriculture and will be subsequently investigated.

Active surveillance

The purpose of the surveillance is to document freedom from IBR. The Swedish Board of Agriculture is responsible for the surveillance, which is implemented by Växa Sverige (the former Swedish Dairy Association). Within the surveillance programme, dairy herds are tested by bulk milk samples and in farms with more than 60 cows, pooled milk samples from individual cows are used. The sampling is conducted twice a year within the Dairy Association's quality control programme and synchronised with the programmes for bovine viral diarrhoea and enzootic bovine leucosis. The surveillance also includes serum samples from beef cattle. Sample size for dairy herds is calculated based on a herd design prevalence of 0.2% and a confidence level of 99%, and for beef cattle on a herd design prevalence of 0.2%, an animal design prevalence of 10% (beef cattle) and a confidence level of 99%.

In addition to the official active surveillance programme, bulls are tested within health schemes at semen collection centres and all cattle (and other potentially susceptible ruminants) are tested before export and import.

RESULTS

Within the active surveillance, 3,351 bulk milk samples and 4,622 serum samples from beef cattle were examined. 318 cattle, 3 reindeer and 13 yak were tested as part of health schemes or prior to export. All samples were tested negative. No herds were investigated due to clinical suspicions of IBR.

DISCUSSION

In summary no herd or individual animal was diagnosed with IBR infection during 2016. This supports Sweden's IBR free status.

Influenza



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BACKGROUND

Influenza type A is a viral disease affecting both birds and mammals, including humans. The causative agent is an RNA-virus of the family *Orthomyxoviridae* with a marked ability to change over time. New strains are created both through accumulation of point mutations ('antigenic drift') and through genetic reassortment (antigenic shift). Influenza type A viruses are classified into different subtypes based on the surface glycoproteins: hemagglutinin (H) and neuraminidase (N).

The main mode of transmission of influenza type A virus is by aerosols containing virus from the airways of infected individuals of the same species. Occasionally influenza type A virus can be transmitted from one species to another, like in the case of avian influenza infecting humans, but typically, each host species has its own influenza type A viruses.

Avian Influenza

BACKGROUND

Avian influenza (AI) viruses are divided into different antigenic subtypes based on the combination of two surface glycoproteins (HxNy). Currently, 18 HA and 11 NA variants have been identified. Except for the H17N10 and H18N11, which have only been found in bats, all other possible combinations can be found in the aquatic wild bird reservoir. The disease is highly contagious and is spread both directly and indirectly. Wild birds are reservoirs for low

pathogenic viruses (LPAIV) including subtype H5 and H7, which upon transmission and further adaptation to poultry may mutate and become highly pathogenic (HPAIV).

The detection of highly pathogenic avian influenza (HPAI) H5N1 in Hong Kong in the middle of 1990s, with the ability to cause disease in humans, highlighted the potential threat of avian influenza to human and animal health.

In May 2005, an outbreak of H5N1 led to the death of over 6,000 migratory waterfowl in Qinghai Lake in western China. This was the first sustained major outbreak with H5N1 viruses within wild bird populations since 1997. Subsequently, H5N1 outbreaks in wild birds or in poultry were reported in Siberia (July 2005), Mongolia and Kazakhstan (August 2005), Romania, Croatia, and Turkey (October 2005). Wild bird infections with or without poultry disease were also noted in several other countries in Europe including Sweden, in 2006. The outbreak of HPAIV-H5N1 in Sweden led to deaths among several species of wild birds, one infected farmed mallard in a game bird holding and a mink.

In early 2014, highly pathogenic avian influenza A(H5N8) viruses belonging to clade 2.3.4.4 of the Gs/Gd-like lineage were detected in wild birds and poultry first in the Republic of Korea, China, Japan and Russian Federation. By autumn the same year, the virus was detected in commercial poultry in Canada and later in December, strains of HPAI were also detected in wild birds and poultry in the United States of America (USA). By the middle of 2015, over 50 million poultry were dead or culled because of the outbreak with the estimated economy-wide losses of 3.3 billion dollars. In November 2014, almost simultaneously A(H5N8) viruses were also detected in The Netherlands, Germany, Italy, the United Kingdom and Northern Ireland and in Hungary. In 2014-2015, outbreaks in Europe were limited to a few commercial poultry holdings and only sporadic cases in wild birds. The last reported detection during the 2014/2015 European outbreaks was two mute swans in Sweden in February 2015.

In June 2016, H5N8 virus was once again detected in wild migratory birds in the Tyva Republic, southern Russia, which prompted the Food and Agriculture Organization (FAO) to issue an alert for potential reintroduction of HPAI-H5N8 into Europe through migration routes.

On 27 October 2016, an infected wild swan with HPAI virus A(H5N8) was reported from Hungary. On 4 November, Hungary reported the first outbreak of HPAI H5N8 in poultry. The virus spread rapidly across central Europe with multiple notifications in wild birds, poultry and zoological collections. Sweden reported findings of 18 H5 positive wild birds through our passive surveillance.

During 2016, 17 countries in the European Union reported a total of 403 outbreaks of HPAI in poultry and captive birds. Most outbreaks occurred in; Hungary (219), France (101) Germany

(28), Poland (22) and the Netherlands (12). For LPAI, 47 outbreaks in poultry and captive birds were reported; France (28), Germany (10), Italy (4), Netherlands (2), Denmark (2) and UK (1). When subtyping was available, HPAI H5N8 was the main finding, but a few findings of H5N5, H5N2 and H5N9 were recorded, as was one case of HPAI H5N1. For LPAI, it was H5N1 and H5N3 and H5N9. H7 was only found in 6 cases, 2 HPAI and 4 LPAI.

Disease Animals

Morbidity in birds infected with HPAIV may be as high as 100%, but depends on the species affected, co-infections, virulence of the virus and other factors. In general, gallinaceous birds, including turkeys and chickens, suffer a more severe disease than waterfowl such as ducks and geese, which may exhibit only minor or no clinical disease. LPAIV infections most often cause asymptomatic infections or mild respiratory disease. HPAIV infections cause variable clinical signs such as cyanosis, respiratory distress, diarrhoea, nervous signs, depression, decreased food and water intake and decreased egg production with altered egg quality. Sometimes the only clinical sign is the sudden death of a large numbers of birds.

Humans

Since 2003, more than 850 human cases of H5N1 infection have been identified worldwide with a death rate of 53%. According to the WHO, most of the positive cases have been diagnosed in Egypt, Indonesia and Vietnam. A decrease of cases was noted during 2016. The majority of human cases of H5N1 infection have been associated with direct or indirect contact with infected live or dead poultry. In addition, a total of 16 laboratory-confirmed cases of human infection with avian influenza A(H5N6) virus, including 6 deaths, have been detected in China since 2013. More than 1,200 laboratory-confirmed cases of human infection with avian influenza A(H7N9) viruses, including 40% deaths, have been reported since 2013. An increase of human cases of A(H7N9) has been noted during the fifth winter season. During this wave, the number of human cases is higher than in previous waves and accounts for 37% of the human cases reported so far. This increased number is most likely due to increased environmental contamination in live bird markets and increased circulation of the virus

among poultry. In February 2017, a new A(H7N9) virus with mutations in the haemagglutinin gene indicating high pathogenicity in poultry was detected in two patients from Guangdong and one patient from Taiwan with a travel history to Guangdong, as well as in environmental and poultry samples. However, this new virus has been detected in only three out of 460 human cases confirmed in the current epidemic wave and in one province only. It is unclear at the moment if the newly emerged highly pathogenic avian influenza (HPAI) virus A(H7N9) will replace the low pathogenic virus or if both will co-circulate in the bird population. One human case with A(H7N2) was diagnosed in December 2016 in USA. The person had close, prolonged unprotected exposure to the respiratory secretions of infected, sick cats at an affected animal shelter. The person had relatively mild illness. Since 1998 several human cases with A(H9N2) have been diagnosed, mainly in China; eleven cases during 2015 and nine cases during 2016. Controlling the disease in domestic animals is the first step in decreasing the risk to humans.

LEGISLATION

Animals

Highly pathogenic avian influenza of all subtypes as well as LPAI of H5 and H7 subtypes are included in the Swedish Act of Epizootic diseases (SFS 1999:657 with amendments) and are notifiable upon suspicion. If AI is suspected or confirmed on a farm, measures will be taken to combat the disease and to prevent further spread according to Council Directive 2005/94/EC.

Humans

All laboratory confirmed cases of influenza are notifiable according to SFS 2015:587, and H5N1 infection is notifiable according to the Communicable Disease Act (SFS 2004:168).

SURVEILLANCE

The Swedish Avian Influenza surveillance programme in poultry and wild birds 2016 was based on Council directive 2005/94/EC and Commission decision 2010/367/EU.

Surveillance programmes have been carried out annually in all member states since 2002 to determine the prevalence of avian influenza viruses, in particular the subtypes H5 and H7. The aim of the surveillance in poultry is to detect infections of avian influenza virus subtype H5 and H7 in different

species of poultry. Surveillance of wild birds contributes to the knowledge of the threats from wildlife to domestic animal health and serves as an early warning system for avian influenza threat to domestic poultry flocks.

Poultry

In 2016, sampling was performed in kept game birds (mallard ducks and pheasants), layers, breeders, small-scale broiler production, turkeys, geese, ducks, and ratites. Ten blood samples from each holding were collected except for holdings with geese, ducks or mallards where 20 samples from each flock were collected. In flocks with fewer individuals than the above mentioned sample size, all individuals were sampled. In total, 2,230 blood samples were taken. Table 6 gives an overview of all poultry flocks sampled in 2008 to 2016. In addition to the surveillance programme, samples were taken on clinical suspicion of avian influenza. On clinical suspicion of AI or Newcastle disease, laboratory analyses for both diseases are generally performed.

The surveillance programme for 2016 was based on representative sampling and the serological analyses were performed at the National Veterinary Institute. All poultry samples were collected at slaughter, except breeders and game birds. Blood samples from these categories of birds were collected at their holdings. Breeders were sampled late in their production period. Samples were analysed using an ELISA (IDEXX Influenza A Ab Test). Positive results were confirmed with haemagglutination inhibition tests (for subtypes H5 and H7) in accordance to the OIE guidelines.

Wild birds

The surveillance in wild birds is passive and based on birds found dead or diseased and submitted for postmortem examination. The distribution of wild birds examined for avian influenza is shown in figure 8. Swab samples (both cloacal and tracheal) taken from these birds were analysed for the detection of avian influenza viral genome by using an M-gene qRT-PCR. Samples found positive for the matrix gene were further analyzed by qRT-PCR specific for the haemagglutinin gene of H5 and H7 and virus pathotyping by amplicon sequencing.

From 2006-2010 there was active surveillance of 2,000-4,500 wild birds annually. Since 2011, the surveillance has been conducted on dead birds submitted for necropsy only.

Humans

Every year during the influenza surveillance season 1,500-2,000 samples are collected from sentinel patients with influenza like illness. These samples are analysed for influenza A and B. If influenza A is detected, further subtyping is performed into A(H1N1)pdm09 and A/H3N2. If influenza A positive samples cannot be subtyped further characterisation is performed to rule out zoonotic influenza A. A further 200-300 of the influenza positive samples from the diagnostics laboratory are subtyped/characterised. The Public Health Agency of Sweden, also performs a specific PCR for A/H5N1, A/H5N6 and A/H7N9 if requested.

RESULTS

Poultry

In 2016, antibodies against influenza virus subtype H5 or H7 was not detected in any poultry holding.

Avian Influenza was investigated following 17 clinical suspicions in poultry or captive birds. Clinical signs as suspicion arose included; increased mortality, production losses and/or eggshell abnormalities. Nine of the suspicions were in commercial flocks (one broiler, one pullet, one game bird (mallards) and six layer flocks). Eight of the suspicions were in very small hobby flocks with hens, mixed species or, on one occasion, pigeons. All suspicions were investigated by PCR on swab and/or organ samples. One very large layer farm and one small hobby flock were confirmed as HPAI H5N8; the other 15 were PCR-negative for influenza. One of the layer farms with suspected AI was found negative for influenza but was instead infected with Newcastle disease virus. In the AI positive cases the symptoms raising the suspicions were increased mortality only.

Wild birds

Autumn migrations of wild birds have been implicated in the incursion of HPAIV into Europe in 2005, 2014 and 2016. Wild birds play a key role in the long-distance spread, introduction into new areas or countries and further local amplification and spread of HPAIV.

Within the passive surveillance programme for 2016, 355 wild birds of 65 different species were sampled of which 59 individual birds were waterfowl or shorebirds. Eighteen wild birds were PCR-positive for HPAI H5N8 (7 water fowl, 7 bird of prey and 4 corvids). One wild mallard was positive for avian influenza but not of the notifiable H5 or H7

type. All other birds were negative for Influenza A virus.

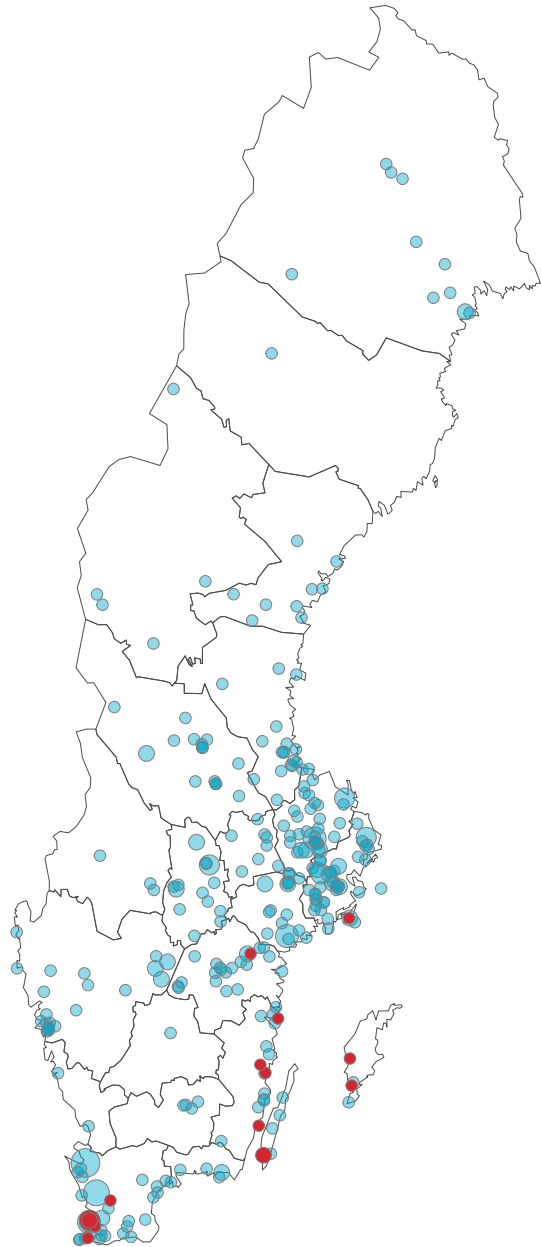


Figure 8: Geographical location of the wild birds analysed for avian influenza in 2016. Point sizes are scaled by the number of birds sampled at a given location. A total of 18 birds were identified positive for influenza H5N8 in 2016.

©EuroGeographics for the administrative boundaries

In November 2016, HP H5N8-virus was detected in a dead common goldeneye (*Bucephala clangula*) in Vellinge, Skåne. Further cases were found in wild birds along the south and eastern coast of Sweden, including the islands of Öland and Gotland.

Humans

Influenza A subtype H5N1, H5N6 or H7N9 have not been identified in any human sample in Sweden.

DISCUSSION

The first large outbreak of HPAI in wild birds was reported from China in May 2005. Thereafter wild birds infected with HPAI have been detected in Europe. HPAI may cause disease and death in wild birds, though there seem to be a host-species dependent susceptibility. Wild birds, especially waterfowl, may be infected with LPAI without the presence of clinical symptoms. Considering the capacity of the virus to mutate and become highly pathogenic (HPAI), wild birds may pose a potential risk to poultry since they may host and introduce LPAI into poultry flocks, where the virus may circulate, mutate and become HPAI.

A recent development in the evolution of HPAI H5N1 virus is the emergence of HPAI H5N8 virus. A HPAI H5N8 virus with genes from viruses of the influenza A(H5N1) A/Goose/Guangdong/1/1996 lineage was first detected in birds on live bird markets in China in 2010. This HPAI H5N8 virus is a reassortant virus with the HA gene segment of HPAI H5N1 virus and other gene segments of multiple other AI viruses circulating in eastern China, and is categorized in the new HPAI H5 virus clade 2.3.4.4 (WHO 2015).

This virus caused a large AI outbreak in poultry in South Korea in the winter of 2013/2014, and subsequently spread to Japan, North America, and Europe, causing AI outbreaks there between autumn 2014 and spring 2015. The H5N8 viruses involved in the 2014/2015 outbreaks in Europe and North America belonged to group A(Buan-like) viruses of clade 2.3.4.4, while the current 2016/2017 outbreaks in Europe belongs to group B(Gochang-Like) in clade 2.3.4.4.

From late 2014 until July 2015 more than 200 poultry farms in the United States was infected with avian influenza resulting in the death and culling of close to 50 million birds of mainly turkeys and layers. In late autumn 2015 a big outbreak of avian influenza in France was detected. The outbreak is localised to an area known for rearing of geese. At the end of 2015, 65 holdings had been found positive. By the end of 2016 France had reported more than 100 additional cases and the outbreak is still ongoing.

The HPAI H5N8 has caused a lot of cases all over Europe during 2016 and the epidemic is still ongoing. During 2016 more than 800 reports on influenza were made to EUs reporting system ADNS, about half in wild birds and half in poultry. The ongoing event further signifies the need for awareness and improved biosecurity in poultry holdings to prevent the introduction of the virus from wild birds.

At the European level, highly pathogenic avian influenza in wild birds has most commonly been found by the passive surveillance programmes. In contrast, the low pathogenic strains have been detected by active surveillance programmes. Therefore, since 2011, the European Commission is no longer economically supporting active surveillance in wild birds. The Swedish surveillance programme in wild birds has been changed accordingly since this decision.

Influenza viruses are unpredictable and changes by mutation or reassortment occur. This might enable the virus to become more transmissible among humans. Monitoring of human infections with these viruses is also critically important to assess their pandemic potential.

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Table 6: Number of flocks of different poultry categories sampled in 2007-2016.

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Laying hens ^A	0	65	61	62	61	52	44	58	68	62
Free range laying hens ^A	-	-	-	-	30	27	16	23	23	30
Turkeys	3	23	17	21	22	19	26	16	18	18
Ducks	3	8	3	4	6	3	1	3	3	4
Geese	6	30	13	11	20	20	13	9	9	7
Broilers ^B	7	28	27	24	39	34	26	12	22	33
Ratites	0	10	6	4	5	3	2	3	3	3
Breeding hens (parents)	0	42	33	34	36	36	36	32	31	34
Breeding turkeys (parents)	4	2	4	3	3	3	3	2	3	3
Game birds (mallards)	7	6	6	7	9	7	7	5	6	7
Game birds (pheasants)	3	23	20	17	15	16	16	12	13	9
Backyard flocks (geese, ducks)	0	0	6	0	0	0	0	0	0	0

^A Until 2011 sampling of all laying hens were reported under the same category regardless of housing system. From 2011, free-range (organic) laying hens are reported separately while the category 'laying hens' includes hens in furnished cages and indoor litter-based housing systems.

^B Small-scale production.

Swine influenza

BACKGROUND

Swine influenza (SI) has a worldwide distribution and causes an acute upper respiratory disease characterised by fever, lethargy, anorexia, weight loss and laboured breathing in pigs. The most commonly occurring subtypes of swine influenza virus (SIV) worldwide are H1N1, H1N2 and H3N2. Of these, the H1N1 SIV was reported to infect pigs in North America already in 1918. In 2009, a new triple reassortant type of influenza H1N1, partly of porcine origin, began circulating among people. In a number of countries including Sweden, this virus has occasionally infected pigs by transmission from humans. This reassortant H1N1 virus became known as influenza A(H1N1)pdm09.

Animals

Influenza H1N1 was isolated from Swedish pigs for the first time in 1982. The clinical signs were severe in the previously naïve pig population, but waned over time. Since 1982, H1N1 virus has been considered endemic in Sweden. Influenza H3N2 is also present in the Swedish pig population. Antibodies to H3N2 were first detected in 1999, but the clinical signs were not as evident as when H1N1 was introduced. Actually, antibodies to H3N2 were first detected in a screening of apparently healthy animals, and it is therefore less clear when this subtype was

introduced. However, H3N2 has since 1999 occasionally been correlated with severe respiratory disease in pigs.

Another swine influenza A type (H1N2) that spread through Europe, was diagnosed for the first time in Sweden in a large multisite unit with respiratory disease in growers during the winter of 2009. Since the first report of the detection of pandemic influenza A(H1N1)pdm09 in early May 2009 in pigs in Canada, H1N1pdm09 has been isolated from pigs throughout the world including several European countries including Germany, Italy, Denmark, Norway, Iceland and Finland. This virus is well adapted to humans and clinical signs of disease in pigs were sparse. In 2013, a new variant of this influenza virus was identified in Swedish pigs where the HA gene revealed high nucleotide identity with contemporary human pH1 strains, suggesting that a recent human to pig transmission was the most likely route of infection in the pigs. The isolate expressed a human pandemic H1N1-pdm09 like HA and a H3N2 SIV-like NA that was closely related to Avian like H1N2 SIV NA from isolates collected in Sweden since 2009. The internal genes were entirely of pandemic H1N1-pdm09 origin which is well adopted to humans. Although the pH1N2 subtype influenza A virus was exclusively prevalent in the Swedish pig population in 2014, the clinical signs of the disease were minor, as later also seen in other countries.



Photo: Maria Sjölund

There has not been a regular monitoring of influenza in pigs in Sweden, but serological screenings were performed in 1999, 2002, 2006 and 2010. At each occasion, 1,000 porcine sera were analysed for H1N1, H3N2 and H1N2. The screening in 2006 also included analyses for antibodies to H5 and H7. During the past five years, 10-15 herds have been sampled annually with special focus on influenza, in these herds influenza virus has been demonstrated in 3-5 herds per year (Table 7).

Infection with influenza virus can produce clinical respiratory disease including dyspnoea, sometimes with nasal discharge and coughing, accompanied by fever, inappetence and lethargy. The disease can affect pigs of varying ages and the severity of clinical signs varies from severe respiratory disease to subclinical infection. The morbidity of affected herds is generally high but mortality is low.

Humans

Globally, 5-10 human cases of influenza virus infections with domains associated to pigs are reported every year. However, human-to-human transmissions of such reassortant virus types are rarely reported. In 2016, 18 cases of human infection with the pig-origin A(H3N2)v virus were detected in USA and one case in Canada. Since 2012 more than 360 humans have been infected with A(H3N2)v in USA and Canada. During 2016 there were three cases

of A(H1N2)v diagnosed in USA. Laboratory confirmed human cases of A(H1N1)v were determined in China (three cases) and one case of A(H1N1)v in Italy, Netherlands and Switzerland, respectively. Human infection with swine influenza has been associated with agricultural fairs where people are in close contact with potentially infected pig populations.

LEGISLATION

All laboratory confirmed influenza is notifiable according to SFS 2015:587.

SURVEILLANCE

Animals

Passive surveillance

During the period from 2009 to 2015, samples from pig herds with respiratory signs consistent with influenza were collected and analysed for presence of the pandemic influenza A (H1N1)pdm09 virus using a polymerase chain reaction (PCR) method. From each affected herd, 5-10 nasal swab samples were collected and analysed first for swine influenza A and if positive, samples were further analysed for pandemic influenza A(H1N1)pdm09. These samples were also investigated for other influenza A types.

Active surveillance

The surveillance in 2010 included 1,008 pig sera collected at slaughter. These sera were randomly selected from the porcine reproductive and respiratory syndrome control programme and included a maximum of 4 sera per herd and sampling occasion. These sera were tested for antibodies to swine influenza types H1N1, H1N2 and H3N2 using haemagglutination inhibition tests (HI). Titres of $\geq 1:64$ were interpreted as significant levels of serum antibodies. For the recently demonstrated influenza H1N2-virus, two HI-tests were carried out, one using a traditional strain and one based on the strain isolated in Sweden (the 9706-strain).

In 2015, the National Veterinary Institute (SVA) and the Public Health Agency of Sweden (FoHM) initiated a study on the transmission of human and swine influenza among farmers, veterinarians and pigs. In collaboration with the farmer's association, ten field veterinarians were asked to select pig farms that were representative of the pig production systems in Sweden and that were owned by producers interested in participating in the study. All workers on the pig farms with a daily contact with pigs, pig farmers and their families were asked to collect nasal swabs from themselves every third week and whenever they had influenza-like symptoms. Concurrently, samples were collected from the pigs at these farms. Participants were asked to complete a health questionnaire about the type of symptoms, duration of illness, and possible exposures to infected pigs. The participants were also asked if they had been vaccinated against seasonal influenza A viruses.

Starting from the last week of January 2015, participating farms were visited every third week for 6 consecutive visits by the field veterinarian. A total of 15 nasal swab samples from pigs were collected at each farm during each visit. During the visit, the age of the pigs and any respiratory clinical signs (absence or presence of sneezing, coughing and nasal secretion) among the sampled individuals was recorded.

The nasal swabs and submission sheets from animals and humans were shipped overnight to SVA or FoHM, respectively.

Nasal swab samples were initially screened for influenza A virus by real-time reverse transcription PCR (rRT-PCR) selective for the matrix gene. Samples positive by rRT-PCR were further analysed for determination of subtype, including the influenza A(H1N1)pdm09 virus using rRT-PCR specific for

hemagglutinin gene of influenza A(H1N1)pdm09 virus. The hemagglutinin and neuraminidase fragments from all positive pig and human isolates were sequenced by the Sanger sequencing method.

Humans

In Sweden, 1,500-2,000 samples are annually collected from patients with influenza like illness during the influenza season in a sentinel surveillance system for influenza. These samples are analysed at FoHM for influenza A and B. If influenza A is detected, further subtyping is performed into A(H1N1)pdm09 and A(H3N2). If Influenza A positive samples cannot be subtyped, further characterisation is performed to rule out zoonotic influenza A. A further 200-300 influenza positive samples from the diagnostic laboratory are subtyped/characterised.

Influenza A(H3N2)v originates from pigs and has caused outbreaks among humans in USA since 2012. Any Influenza A(H3N2) positive samples in the Swedish sentinel system since 2013 from patients below 15 years of age are therefore further analysed for A(H3N2)v. No cases of Influenza A(H3N2)v have been diagnosed in Sweden.

RESULTS

Animals

Passive surveillance

Samples from 7 herds with respiratory signs were analysed for swine influenza virus in 2016 (Jan 1st to Dec 31st 2016). In two of these herds, influenza A virus was detected. The pandemic A(H1N1)pdm09 virus was demonstrated in both herds. Complete genome sequencing and phylogenetic analysis of the obtained sequences of the virus isolated from one of these herds revealed close relationship between the swine A(H1N1)pdm09 virus and the concomitant human A(H1N1)pdm09 viruses circulating in 2016 indicating reverse zoonotic transmission of the virus from human to pigs.

Active surveillance

No active surveillance was performed in 2016.

The surveillance in 2010 revealed low frequencies of pigs with significant levels of antibodies to swine influenza types H1N1, H1N2 and H3N2 using HI tests (Table 7). It is, however, notable that the prevalence of pigs with significant levels of antibodies to H1N2 increased somewhat when the analysis was based on the recent Swedish isolate of the strain.

No pigs with clinical disease were observed during the 6 visits to 10 farms as part of the study on the transmission of human and swine influenza among farmers, veterinarians and pigs. Out of ten participating farms, four farms had at least one positive result during this period and two farms were tested positive on at least two occasions. In total, 825 swabs collected from pigs and 330 swabs collected from humans were analysed for the presence of influenza A viruses. Of these, 19 samples (2%) were positive for influenza A viruses with rRT-PCR.

Humans

The influenza season of 2015–2016 was dominated by influenza A(H1N1)pdm09, with a small wave of influenza B/Victoria towards the end of the season. Overall, the season had high activity but slightly fewer laboratory-confirmed cases compared to the previous, intense season. The season had a high number of severe cases and significant excess mortality was observed in the 15–64 age group.

Influenza A (H3N2)v has not been identified in any sample from humans in Sweden.

DISCUSSION

The results indicate presence of, but no large impact of swine influenza in the Swedish pig population. In the serological screening carried out in 2010, the incidence of influenza H1N1 and H3N2 was low. The prevalence of pigs with significant levels of serum antibodies was lower during 2010 than 2006. Also the prevalence of pigs with significant

levels of serum antibodies to H1N2 was low, regardless of the origin of viral strain used for the analysis. The reactions defined as low, indicate unspecific reactions rather than true antibodies to the influenza strains analysed for. Still, the difference in results depending on H1N2-viral strain used for analysing, illustrates the necessity to include relevant influenza strains (Table 7) in the testing protocol.

In last five years two new influenza A viruses were detected in the Swedish pig population. Both of these viruses were the result of multiple reassortments between avian or/and human and swine influenza A viruses. Influenza A viruses are unpredictable and changes (mutations or reassortment) might be induced. This could enable the virus to be more transmissible among humans. The veterinary medical importance and the public health significance of influenza A virus in pigs should not be underestimated. Monitoring of human infections caused by these viruses is critically important to assess their pandemic potential.

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Table 7: Reactors from the serological surveys performed in 2006 and 2010. The table shows the prevalence of significant seroreactors to the three porcine adapted strains of influenza present in the country. The table also shows the prevalences with low reaction in the HI tests. Note the difference in prevalences depending on strain used for antibody detection for H1N2 in 2010.

Seropositive samples	H1N1	H3N2	H1N2-standard	H1N2 new (9706strain)
Significant levels of antibodies ($\geq 1:64$)				
2006 (n=999)	33.0%	6.7%	0.6%	-
2010 (n=1,008)	0.6%	3.7%	0.1%	0.9%
Low levels of antibodies ($\leq 1:32$)				
2006 (n=999)	15.1%	18.8%	7.0%	-
2010 (n=1,008)	2.3%	9.6%	1.3%	5.1%

Leptospirosis

BACKGROUND

Several species of the spirochetal bacterium *Leptospira* can cause leptospirosis. All mammals including humans, are susceptible to one or several *Leptospira* serovars. Leptospirosis occurs worldwide but the dominant serovars vary by region. Cattle are considered the reservoir for *L. Hardjo* and pigs for *L. Pomona*. Between 1994 and 2006 sampling and testing for antibodies to *L. Hardjo* and *L. Pomona* in cattle and pigs, respectively, was performed each year and after 2006 every third year.

Leptospira may be transmitted directly between animals or indirectly in the environment. The bacteria do not multiply outside the host, but may survive for long periods in the environment.

DISEASE

Animals

L. Hardjo is one of several pathogenic serovars and is associated with disease in cattle, sheep, goats and horses. Infections may be acute or chronic; asymptomatic, mild or severe. Acute disease is more often seen in calves. Disease in adults may go unnoticed, because the early clinical signs of fever and depression are often transient and mild. Infected herds may have problems with abortions, decreased fertility and decreased milk yield as well as increased mortality in calves. The clinical signs in sheep and goats are similar to those in cattle. Sheep and cattle can act as reservoir hosts because the disease may be asymptomatic. *Leptospira* infections in pigs may also be asymptomatic or may give rise to reproductive failure. In piglets, fever, gastrointestinal disorders and jaundice may be present. The clinical presentations in dogs infected with *Leptospira* range from subclinical to severe clinical illness affecting the kidneys and liver.

Humans

Leptospirosis in humans ranges from asymptomatic or mild influenza-like illness to a severe infection with renal and hepatic failure, pulmonary distress and death.

LEGISLATION

Animals

Since 2004, leptospirosis is a notifiable disease in Sweden (SJVFS 2013:23).

Humans

Leptospirosis in humans is notifiable according to the Communicable Disease Act (SFS 2004:168 with the amendments of SFS 2013:634).

SURVEILLANCE

Animals

Passive surveillance in animals involves mandatory case reporting of laboratory confirmed cases. Animals sampled for export and in breeding centres adds to the passive surveillance.

The active surveillance in cattle is focused on *L. Hardjo* and is based on serum and bulk milk samples selected by convenience sampling from the surveillance programme for bovine viral diarrhoea virus (BVDV) and evenly distributed throughout the sampling period. See chapter on BVDV for details on sampling and population. The surveillance was designed using a between-herd design prevalence of 0.2%, a within-herd design prevalence of 40% and a risk of introduction of 1 in 50 years.

In domestic pigs, the active surveillance is based on samples collected for the abattoir sampling part of the surveillance carried out by Farm & Animal Health for porcine reproductive and respiratory syndrome (PRRS). See chapter on PRRS for details on sampling and population. The surveillance is focused on *L. Pomona* and the surveillance was designed using a between-herd design prevalence of 0.5%, a within-herd design prevalence of 40% and a risk of introduction of 1 in 25 years. Active surveillance in cattle and pigs is at present performed every third year.

The serological analyses were performed at the National Veterinary Institute. The diagnostic test used for *L. Hardjo* was an indirect ELISA (PrioCHECK *L. Hardjo*, Antibody detection ELISA, Lelystad, Holland) for both blood and bulk milk samples. Positive blood samples were further tested with MAT (Microscopic agglutination test) with results reported as positive at 1:100 or above. For positive or doubtful ELISA results on bulk milk samples, an investigation was carried out in the herd and additional individual samples were taken. *L. Pomona*-antibodies were analysed using the microscopic agglutination test (MAT) with results reported as positive at 1:100 or above.

Humans

The surveillance in humans is passive.

RESULTS

Animals

In 2016, 15 cases of *Leptospira* infection were reported in dogs and two in horses.

During 2016, 1,350 serum samples and 450 bulk milk samples from approximately 1,800 cattle herds were analysed for *L. hardjo* antibodies and 397 serum samples from pigs (one sample per herd) were analysed for *L. Pomona* antibodies. All cattle samples were negative for *L. hardjo* and all pig samples were negative for *L. pomona* antibodies.

Humans

In 2016, one case of leptospirosis was reported. This case had acquired his infection abroad, in Jamaica. Cases infected outside Sweden have often acquired their infections during leisure activities in contact with water. In 2016, the reported case was a man in his 50s.

DISCUSSION

Leptospirosis occurs worldwide, but the predominant serovars vary by geographic region. The disease is associated with reproductive losses in cattle and significant economic costs worldwide. Certain *Leptospira* serovars are present in Sweden. Occasional cases of pigs serologically positive to *Leptospira* spp (other than *L. Pomona*) are diagnosed in

Sweden, mostly to an indigenous serovar of *L. Sejroe* (Mouse 2A), *L. Bratislava* and *L. Ichterohaemorrhagiae*. An even lower prevalence to the indigenous strain *L. Sejroe* (Mouse 2A) in cattle has been recorded.

Swedish cattle and the commercial pig population are considered to be free from *L. Hardjo* and *L. Pomona* based on only negative results from the surveillance system since 1994. Since 2006, the surveillance programme in cattle and pigs is no longer performed on a yearly basis as the serological screening of *Leptospira* is considered of less importance compared to screening programmes of other contagious animal diseases. Also, human infections are mainly travel-associated. The Swedish Board of Agriculture can decide to initiate an epidemiological investigation in case of clinical disease consistent with leptospirosis in animals.

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Listeriosis



Photo: Torsten Mörner

BACKGROUND

The genus *Listeria* contains several species but *Listeria monocytogenes* is the only zoonotic species and was first described in 1926. Previously, sporadic cases of listeriosis were reported, often in employees in contact with diseased animals but since the 1980s outbreaks of listeriosis have been traced to food products.

Listeria bacteria are widely distributed in the environment, such as in soil, silage and water. They can survive for long periods in the environment and tolerate disinfection and also grow at refrigeration temperatures. These properties make elimination of *L. monocytogenes* difficult. The main sources of human listeriosis are contaminated food products, such as smoked or gravad vacuum-packaged fish products, meat products and soft cheeses or other ready-to-eat foods with a long shelf-life. The infection can also be transmitted from infected animals to

humans or via person-to-person contact. The environment and animals serve as important reservoirs of the pathogen.

L. monocytogenes is destroyed by heating (pasteurisation and cooking). The bacterium is able to grow in vacuum-packed food, at refrigeration temperatures and in modified atmospheres. *L. monocytogenes* is often found as an environmental contaminant in food premises.

In Sweden, during the last ten years approximately 50-120 human cases have been reported annually. Outbreaks have been associated with vacuum-packaged fish (1995-1996, 2013-15), with cheese made of unpasteurized goat's milk (2001) and with cold cuts (2013-2014). Though the number of cases have decreased since 2014, a trend analysis shows a statistically significant increasing trend of cases of listeriosis in Sweden (Figure 9).

DISEASE

Animals

L. monocytogenes can infect a wide range of animal species, both domestic and wild. Animals may be asymptomatic carriers and shed the organism but especially sheep may develop clinical disease, such as neurological symptoms, abortions, mastitis or septicaemia.

Humans

Listeriosis can be manifested either as a milder non-invasive form or as a severe invasive disease. The non-invasive form is mainly febrile gastroenteritis. The severe form most often occurs in immunocompromised persons, newborns, pregnant women and elderly people. Symptoms of invasive listeriosis are septicaemia, meningitis and meningoenzephalitis. For those with severe infection, the mortality rate is high (20-40%). The infection can lead to miscarriage, premature delivery or neonatal death. The incubation period of listeriosis varies from 3-70 days, with an average incubation of 21 days.

LEGISLATION

Animals

Listeriosis is a notifiable disease in animals according to SJVFS 2013:23.

Food

Criteria for *L. monocytogenes* in foods are specified in the EU-regulation on microbiological criteria (EC 2073/2005). Food business operators shall ensure that foodstuffs are in compliance with the regulation. Different criteria apply to ready-to-eat (RTE) foods in which growth of *L. monocytogenes* can occur and in RTE foods in which growth of *L. monocytogenes* will not occur during their shelf-life.

Humans

The invasive form of listeriosis has been a notifiable disease in Sweden since 1960. It is notifiable in humans for both clinicians and laboratories according to the Communicable Disease Act (SFS 2004:168 with the amendments of SFS 2014:1549).

SURVEILLANCE

Animals

Surveillance in animals is passive. Notifications are based on clinical cases and laboratory analyses. The diagnosis can be based on histological findings at necropsy or by detection of the organism by cultivation methods using enrichment in selective broth

followed by culture on selective and non-selective agar. Identification is made by biochemical methods. The Swedish Board of Agriculture can decide on epidemiological investigations if needed.

Food

No official control programme exists. Sampling is performed by national and local authorities, mainly at retail level but also at production units. Sampling performed by the industry is not normally reported to the authorities. Analysis is based on cultivation methods according to EN/ISO 11290-1 and 11290-2 or NMKL 136 or other methods available at accredited laboratories. The ISO-standard is being revised and is expected to be published in June 2017.

Humans

The surveillance in humans is passive. Isolates from human cases are sent to the Public Health Agency of Sweden for typing using whole genome sequencing (WGS) to verify molecular serotype and for cluster detection. As a conventional nomenclature tool, not only the serotype but also the Multi Locus Sequence Typing (MLST) type, ie. ST-type, is defined by WGS.

RESULTS

Animals

In 2016, listeriosis was reported in 18 sheep, six cattle, two goats, one dog, one horse, one fallow deer and in one alpaca.

Food

Available results from official sampling by local authorities at food enterprises showed that 1,063 samples from various food products were analysed and *L. monocytogenes* was detected in 22 of these samples.

Part of these samples was taken within the framework of a national coordinated control project. The project was run from February through December 2016 in cooperation between the National Food Agency and local authorities. In all, 601 samples (311 samples of cold cuts and 290 samples of cold smoked or gravad fish) were collected from stores and analyzed both qualitatively and quantitatively at the end of the shelf life. Of these, three samples (1 percent) of cold cuts and 11 samples of cold smoked or gravad fish (4 percent) were positive for *L. monocytogenes*. The counts of the pathogen exceeded 100 cfu/g in two (0.7 percent) of the samples of cold smoked or gravad fish. In all other positive

samples the counts of *L. monocytogenes* were lower than 100 cfu/g.

Humans

In 2016, 68 cases of listeriosis were reported (incidence 0.69 cases per 100,000 inhabitants). (Figure 9). This was a decrease in number of cases compared to the year before when 88 cases were notified. The majority of the cases reported with listeriosis belong to the older age-groups. In 2016 the median age was 73 years and 66% were people over 70 years. As previous years, the highest incidence was found in the age-group over 80 years (4.5 cases per 100,000 inhabitants). Of the reported cases, 53% were women, of which two were pregnant. In total 25% of the reported cases died within one month from diagnosis.

The counties with the highest incidences of listeriosis in 2016 were Norrbotten (incidence 2.0), Jämtland (1.6) and Dalarna (1.4).

Listeriosis is most often a domestic infection, probably because the majority of the cases are elderly people who are too sick to be travelling. During 2016, 62 cases (91%) were reported with Sweden as country of infection. Three cases were reported as infected abroad and three cases had missing information about country of infection.

In 2016, all but three (96%) of the human isolates were sent in to the Public Health Agency of Sweden for typing. The most common molecular serotypes were IIa (75%), IVb (20%), IIb (3%) and IIc (2%). In addition to serotypes, 22 different ST-types were identified of which the majority belonged to serotype IIa. Some ST-types have also been associated with different food categories, for example ST7 with cold cuts and ST19 with fish products.

During 2016 no outbreak of listeriosis was identified but one case had the same strain of serotype IIa (ST19) as the one causing a national outbreak over the time period 2013-2015. The suspected source of infection was vacuum-packaged smoked and/or marinated salmon. Another case had an identical serotype IIa (ST8) strain to a strain isolated from homemade marinated salmon. One case with a serotype IVb (ST4) strain got infected from cold cut sausage (rullepølse) bought in Denmark. The strain was also identified in a Danish patient and in environmental samples from the production plant producing the cold cuts in Denmark.

DISCUSSION

Despite a decrease in human cases of listeriosis in Sweden since 2014, the overall picture is an increasing trend of listeriosis over the period 1983-2016. (Figure 9). The same trend has been observed in other European countries. The reasons for the increase remain unclear but are most likely related to a combination of factors such as an ageing population, a widespread use of immunosuppression medications and consumer preference changes to more ready-to-eat foods. The European Centre for Disease Prevention and Control (ECDC) collaborate with the member states to strengthen the molecular surveillance to be able to detect cross-border clusters and outbreaks.

The case-fatality rate of listeriosis is high. Approximately one third of the patients die within three months. Since most of the patients suffer from severe underlying diseases the impact of listeriosis is difficult to estimate. The microbiological criteria for *L. monocytogenes*, set in 2005, determine the standard the industry has to achieve for their products to be considered safe for consumers. The results from the 2010 survey, described in the surveillance report from 2012, showed that the fish industry still has problems with *L. monocytogenes*. The results indicate that this is a problem primarily in packaged cold-smoked and gravad fish.

Surveillance of *L. monocytogenes* in humans and in food and food processing environments will be essential for understanding the sources for human infection and giving tools to prevent infections. For detection of outbreak clusters of *L. monocytogenes* and for identifying possible links between humans and food products, subtyping of isolates is essential.

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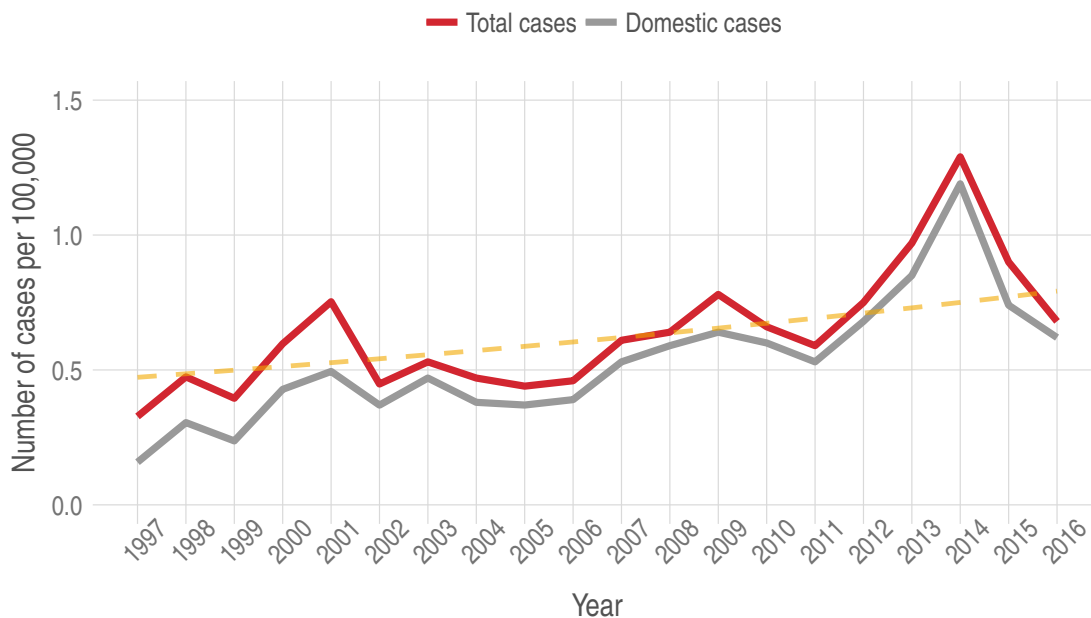


Figure 9: Notified incidence (per 100,000 inhabitants) of human cases of listeriosis in Sweden 1997-2016. The yellow dashed line shows the result of a statistical model showing a significantly increasing trend over time.

Maedi-visna



Photo: Torsten Mörner

BACKGROUND

Maedi-visna (MV) is a globally distributed contagious disease in sheep, first described in Iceland in 1939. The causative agent is a lentivirus in the Retrovirus family. Transmission between animals occurs most commonly via the oral route (mainly via milk), but may also occur via inhalation of infected aerosol droplets. The incubation period is long. The first case of MV in Swedish sheep was officially reported in 1974. Fifteen years later the among-flock seroprevalence was 8.2% as demonstrated by sampling of randomly selected sheep at abattoirs. A voluntary control programme for MV was launched by Farm & Animal Health in 1993 and an additional simplified version with single sampling of sheep and goats to identify and enrol flocks into the control programme started in 2005. The simplified version is not regulated within the Swedish legislation and does not require the same obligations from the farmers. The control programme and the simplified version of it are running in parallel.

Data from all affected flocks have been recorded since 1993.

DISEASE

Only the maedi form of MV is occurring in Swedish sheep flocks; a progressive viral pneumonia. The disease typically remains latent in the flock for several years before appearing with clinical manifestations. In an advanced stage of the disease the typical clinical signs are severe emaciation and respiratory distress in older ewes. In highly infected flocks clinical signs can also appear in younger sheep. After the appearance of clinical signs the outcome is always fatal within weeks to months.

LEGISLATION

MV is a notifiable disease (SJVFS 2013:23).

SURVEILLANCE

The purpose of the control programme is to eradicate MV from Swedish sheep flocks. Documentation of the MV status in the flocks is essential. By

identifying infected flocks for disease control and taking measures, the spread of MV stops and eradication is possible. Prevention of introduction of MV into flocks is crucial.

The programme is based on serological testing of sheep at farm level. A flock specific Maedi status is achieved by repeated blood sampling and testing. A contract on an agreement that all sheep in the flock are individually identified and kept in record is signed by the farmer. Purchase of sheep is only allowed from flocks with a similar or higher MV status.

Serological testing is performed on all sheep older than one year. Negative serology grants the flock an M1-status. A second sampling performed 12-16 months later grants an M2-status if all samples are negative for MV antibodies. This procedure is repeated 12-16 months later and a negative result grants an M3-status, which means that the flock is declared free from MV. The MV free status is maintained by an assurance of the animal keeper. An indirect control of the M3 status holdings is performed by testing of sheep from holdings entering the programme as these new animals are mainly bought from M3 status flocks. If antibodies are detected in a flock, either the whole herd is culled or other eradication measures including selective slaughter is performed, depending on the prevalence of positive sheep within the flock.

Goats and goat herds can also be enrolled in the MV programme.

The programme is based on serological examination of blood samples for antibodies against MV virus with an AGID-test (agar gel immunodiffusion) for which the antigen is purchased from the Animal and Plant Health Agency. Samples with inconclusive or seropositive results are retested with ELISA (Synbiotic's Elitest MVV/ CAEV), which is also used for flocks under partial eradication and very small flocks with less than five sheep.

Post mortem examinations and histopathology are still important tools to detect MV. Diagnostic testing is performed at the National Veterinary

Institute. Serum samples collected in the MV-programme are also used for other surveys (Brucellosis and Tuberculosis).

RESULTS

During 2016, 18,000 samples from 749 sheep (and a few goat) flocks were analysed in the MV control programme for antibodies against MV virus.

At the end of 2016, 3,536 flocks with 135,003 sheep were declared free from MV corresponding to about half of the Swedish sheep population. Approximately 2,000 samples from 129 flocks were analysed within the simplified programme.

In total during 2016, four flocks were considered positive of which all were goat flocks, three of them previously untested, and one had a history of previous culling for MV/CAE.

DISCUSSION

The MV control programme has been running for many years. A huge number of samples have been collected and analysed, and extensive knowledge has been gathered about introduction and appearance of MV in sheep flocks, and diagnostic tests pro's and con's. Thus the programme is very solid. A revision of the programme was made during 2013 by Farm & Animal Health and the National Veterinary Institute. Since July 2014, the programme was refined to reduce sampling in long term MV free and well documented flocks and increase sampling in risk areas and higher risk flocks.

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Nephropathia epidemica



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BACKGROUND

Nephropathia epidemica (NE) is caused by Puumala virus, a member of the Hantavirus genus in the *Bunyaviridae* family. Hantaviruses are the cause of rodent-borne haemorrhagic fevers with renal syndrome (HFRS) and hantavirus pulmonary syndrome (HPS). Puumala virus is likely to be the most prevalent hantavirus in Europe. The virus is excreted in saliva, urine and faeces from its natural reservoir, the bank vole. Puumala virus can remain infectious in bank vole cage bedding for two weeks. Transmission to humans often occurs in an aerosolised form. Humans may be exposed to virus aerosols during occupational or recreational activities, such as working with hay, cleaning barns or summer cottages, cutting wood and entering buildings contaminated with rodent excretions.

Nephropathia epidemica was first described by two Swedish physicians independently in 1934. The linkage to the bank vole was suggested many years later. The virus was first isolated in 1982 in Puumala, a municipality in south-eastern Finland.

In Sweden, between 50 and 600 cases are reported each season with a considerable interannual variation coupled to the 3-4 year population cycle of the bank vole. During the winter seasons 2006-2007 and 2007-2008 the number of notified cases rose to 1,400, where most of the cases occurred in the 2007 calendar year (Figure 10). It is hypothesised that a parallel occurrence of a peak in the bank vole population and lack of snow cover in December, 2006 caused bank voles to seek refuge in buildings and barns, hence increasing their contact with humans.

DISEASE

Animals

In the bank vole, the infection is understood to be subclinical.

Humans

The clinical picture is characterised by a sudden onset of high fever, headache, backache and abdominal pain. The symptoms range from sub-clinical to renal failure requiring intensive care and dialysis, but fatal cases are rare. The incubation period varies

from 2 to 6 weeks.

LEGISLATION

Animals

Hantaviruses are not notifiable in animals.

Humans

Nephropathia epidemica has been notifiable since 1989 according to the Communicable Disease Act (SFS 2004:168 with the amendments of SFS 2013:634).

SURVEILLANCE

Animals

There is no surveillance in animals.

Humans

The surveillance in humans is passive.

RESULTS

Humans

In 2016, 92 cases of NE were reported, which was a decrease in comparison to the previous year (Figure 10). Most reported cases were in the age category between 50 and 69 years and the median age was 57.5 years. Just one child below the age of 10 was reported. Consistent with previous years, more cases were reported in men (60%) than in women. The reason for this difference in incidence between

age groups and sexes is not completely understood, but behaviour is most likely an important factor.

Most of the reported NE cases have acquired their infections in Sweden. In 2016, there was only one case infected abroad, in Finland.

A majority of the cases (85%) were reported from the four northernmost counties in Sweden. In Västernorrland the incidence was highest (11 cases per 100,000 inhabitants) and in the counties of Jämtland, Norrbotten and Västerbotten there were 4.7-9.6 cases per 100,000 inhabitants. This regional pattern is consistent with previous years. There were not so many cases reported during the first half of 2016. In the four last months of the year 57% of the cases were reported.

DISCUSSION

During recent years, fluctuations in the bank vole population have coincided with increases and decreases in the number of human cases of Puumala virus infections. The 3-4 year natural population cycle and variations in the climatic conditions impact the rodent populations.

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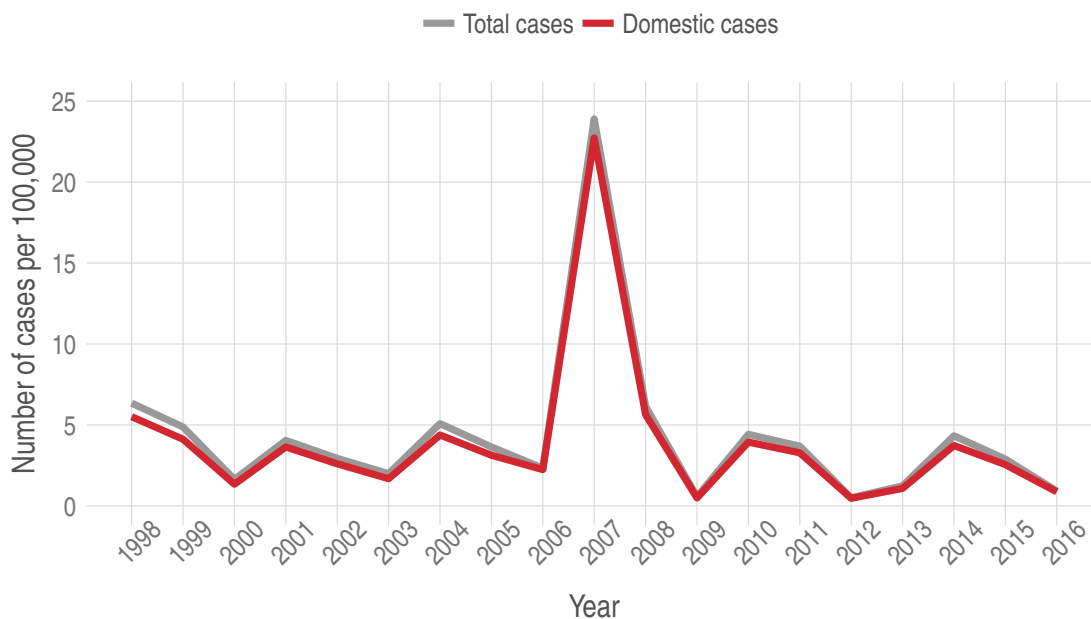


Figure 10: Notified incidence (per 100,000 inhabitants) of human Nephropathia epidemica in Sweden 1998-2016.

Paratuberculosis

BACKGROUND

Paratuberculosis is a common disease of ruminants in most parts of the world caused by *Mycobacterium avium* subsp. *paratuberculosis* (MAP). Sweden has a unique situation, where the prevalence of the disease is extremely low, or not present at all. However, sporadic cases have previously occurred in beef cattle, all of them connected directly or indirectly to imported animals. The latest case was detected in 2005. Throughout the 20th century, detection of such cases has been followed by whole herd stamping-out, tracing and sanitation measures, with the goal to eradicate the disease and to prevent spread of infection.

Paratuberculosis has never been detected in dairy cattle, other ruminant species or wildlife in Sweden. The overall purpose of the surveillance and the voluntary control programme in beef herds is to document freedom from bovine paratuberculosis and to prevent possible spread by early detection of the infection.

Previous active surveillance

Tracings and several screenings in cattle initiated after detection of a positive beef cow in 1993:

- Screening of 200 dairy herds in the years of 2000, 2003 and 2005.
- Since 2004 all ruminants above one year of age, submitted for necropsy, are sampled for MAP and assessed by culture. Sampled animals also include exotic ruminants like buffalo and camelids.
- Screening of sheep herds during the years 1993- 2011, first with serology, then with faecal culture. The screening of sheep was discontinued in 2012.
- In 2007-2009 faecal culture screening of beef herds with animals imported during 1990-2005. In 2012 another screening of beef herds with animals imported during 2005-2011 was done.
- Screening of older cows at abattoirs in 2009-2010, aimed at a risk group including cows older than six years with signs of weight loss, resulted in 1211 sampled cows.

In 2012-2013, a campaign to raise the awareness of the disease among owners and veterinarians was initiated to improve the passive surveillance. Bovine practitioners were encouraged to look for and sample cows with low bodyweight, with or without diarrhoea. The 258 samples were analyzed by faecal PCR.

DISEASE

Paratuberculosis, also known as Johne's disease, is an intestinal infection in ruminants caused by *Mycobacterium avium* subsp. *paratuberculosis* (MAP). The bacteria is excreted in the faeces of an infected animal and the normal transmission route is faecal to oral. It causes chronic diarrhoea and emaciation resulting in suffering and death. If present, the disease causes great economic losses due to reduced milk production, reproductive losses and increased replacements of affected animals.

The incubation period is several years. In areas with endemic infection, clinical disease is most commonly seen at the age of 2-5 years. There is no reliable method to detect the infection in the individual animal during the incubation period.

The zoonotic potential of MAP cannot be ignored and there are ongoing discussions about MAP as a possible contributing factor to the development of Crohn's disease in humans.

LEGISLATION

Paratuberculosis (Johne's disease) has been included in the Swedish Act of Epizootic diseases since 1952 (SFS 1999:657 with amendments). Vaccination is prohibited by law and notification of the infection is mandatory on clinical suspicion. Whole-herd slaughter with subsequent sanitation and tracing of animal trade is performed if MAP is detected in a herd.

SURVEILLANCE

Diagnostic tests

Cultures were pre-treated with HPC and double incubation. Samples were subsequently cultured on modified Löwenstein-Jensen medium supplemented with mycobactin and on Herrolds Egg Yolk medium for up to 4 months. Faecal samples from sheep were cultured for up to 6 months, on both modified L-J with mycobactin and modified Middlebrook 7H10

with mycobactin. Direct PCR on a new preparation from the stored samples was performed on samples that had mould overgrowth in the culture.

Samples collected because of clinical suspicion and individual faecal samples from the beef herd control programme during 2016 were analysed with direct PCR.

All tests for detection of MAP bacteria were performed at the National Veterinary Institute

Passive surveillance

Notification, sampling and diagnostic testing are mandatory in animals of any ruminant species exhibiting clinical signs that lead to suspicion of paratuberculosis. Sampling includes faecal samples from live animals and post mortem samples from dead or culled animals. The latter consists of samples from the ileal wall, ileal contents and ileocaecal lymph nodes as well as any macroscopic lesions in the intestines. Wildlife is sampled when MAP is suspected at necropsy.

Active surveillance

Control programme for surveillance in beef cattle

In the voluntary control programme, the target population is beef herds that sell animals for breeding. The programme is managed by Farm & Animal Health and financed by the Swedish Board of Agriculture. In total, at the end of 2016, the control programme for bovine paratuberculosis encompassed 435 herds, of which 419 are of the highest status. The control programme includes all main breeding beef herds and a smaller number of dairy herds selling calves to beef herds within the program.

The programme underwent some changes in 2011. In affiliated herds, individual faecal samples are collected annually for three consecutive years, from all cattle over two years of age and all purchased animals from one year of age. Affiliated herds are only allowed to trade with herds of the same status or higher to keep their level within the programme. After three years of negative test results, the faecal sampling is replaced by necropsy of all euthanised or deceased cattle on the premises where paratuberculosis cannot be excluded as a cause of culling.

Post mortem examinations

Sampling is performed on all ruminants above one year of age submitted for post mortem examinations. Samples are taken from the ileal wall, ileal contents and ileocaecal lymph nodes and submitted to the

National Veterinary Institute.

Health controls for export reasons

Twenty-five cattle were serologically tested for export reasons. A zoo animal, an addax antelope, was tested by PCR. The choice of analysis depends on the recipient country.

RESULTS

In 2016, five animals were investigated due to clinical suspicion of MAP. All animals were tested by faecal PCR with negative results. In 2016, 36 herds were sampled within the control programme for surveillance in beef herds, resulting in 879 individual samples (801 cattle from 28 herds, 51 sheep from 7 herds and 15 water buffalo from one herd).

Four hundred and sixteen animals were sampled at post mortem examination; 207 cattle, 177 sheep, 9 goats and 17 exotic ruminants (10 alpacas, 4 bison and 3 yaks). In addition, 6 kept deer from three holdings was sampled at autopsy. One positive serological result was initially obtained from a bull sampled for semen export. The serum sample was taken years previously and the bull was no longer alive when the sample was analysed. The bull had been repeatedly tested and had negative tests both before and after the actual sample. Together with an epidemiological investigation it was concluded the bull was not infected with paratuberculosis. No cases of MAP were detected in any of the examinations completed in 2016 (Tables 8 and 9).

DISCUSSION

The prevalence of MAP in Swedish ruminants remains at a very low level, if present at all.

The screenings of beef herds with cattle imported from 1990-2011 was targeting the highest risk group of animals for MAP in Sweden; MAP has been detected in no other breeds or species than beef cattle and all cases have been traced back to imported animals with the latest case back in 2005.

Fallen stock is considered a risk category for MAP and therefore all ruminants older than one year of age, submitted for post mortem examination, are sampled for MAP and examined by culture. All herds affiliated with the control programme must send fallen stock for post mortem examination if paratuberculosis cannot be ruled out as a cause for death or culling. The post mortem sampling also includes other susceptible species, like sheep, goats and exotic ruminants. The exotic ruminants are

sometimes imported, or kept in herds with other exotic ruminants imported from countries where MAP is prevalent.

In a study by Frössling and co-workers (2013), the probability of freedom and sensitivity of the surveillance system for MAP was estimated. Results show that, at the end of 2008, there was a high probability that the Swedish cattle population was free from or had a very low prevalence of MAP. However, a recent update of this evaluation has showed that the surveillance sensitivity in the last years as decreased. This supports the need for continued investigations of Swedish herds and animals, especially imported individuals, as imports of susceptible species pose the greatest risk to introduction of MAP to the Swedish cattle population.

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Table 8: Screening of cattle and exotic ruminants.

Surveillance in cattle and exotics	No. of sampled animals	No. of herds
Beef herd surveillance programme	816 ^A	28
Sampled cattle at post mortem examinations	207	167
Sampled exotic ruminants at post mortem examinations	17	11
Sampled cattle for export	25	1

^A Including 15 water buffalo from one herd

Table 9: Screening of sheep and goats.

Surveillance in sheep	No. of sampled sheep	No. of herds
Sheep sampled in cattle herds within the beef herd surveillance programme	51	7
Sheep sampled at post mortem examinations	177	137
Goats sampled at post mortem examinations	9	9

Porcine reproductive and respiratory syndrome

BACKGROUND

Porcine reproductive and respiratory syndrome (PRRS) is caused by an enveloped RNA-virus belonging to the family Arteriviridae and the disease affects domestic pigs. PRRS is a highly contagious disease transmitted between pigs through both direct and indirect contact.

Seropositive feral pigs and wild boars have been described but there is no evidence of wild boar being a reservoir for PRRSV in Sweden. The disease was first described in USA in 1987 and the virus was subsequently identified in 1991. Since then, PRRSV has spread and is endemic in most of the pig populations of the world. It is considered to be one of the most economically important viral diseases in swine production. In 2006, an atypical variant of PRRSV was reported from Asia. This variant causes more severe clinical signs and higher mortality than previously described genotypes of the virus.

In 1998, Farm & Animal Health launched a surveillance programme for PRRSV in which the Farm & Animal Health is responsible for the sampling and the National Veterinary Institute performs the analyses. The first case of PRRS in Sweden was confirmed in July 2007. Until then, Sweden was one of few countries that had declared themselves free of PRRSV. The outbreak was detected through the active surveillance programme. Since the disease was not widespread at the time of detection, a decision was made to control the outbreak through a modified stamping out procedure. The actions taken to eradicate the disease proved to be effective and following extensive surveillance during the fall of 2007, Sweden was declared free from the disease with a high probability in the beginning of 2008. Despite extensive investigation, the source of the outbreak could not be established.

After the outbreak in 2007, the surveillance programme was revised in order to enable even earlier detection of an introduction of PRRSV. Another revision of the programme was done in 2012 following extensive changes in the pig production in Sweden.

DISEASE

Infection with PRRSV causes varying clinical signs depending on the age of the infected animals. The incubation period is 2-7 days (usually 2-3 days) and in adult swine the clinical signs are usually mild, consisting of fever and inappetence for a few days. The devastating effect of PRRSV infection in this category of animals is that it causes reproductive failure including abortions, mummified foetuses, small litters and increased incidence of non pregnant sows. In fattening pigs the infection mainly causes respiratory signs.

The atypical variant of PRRSV may cause high fever, discolouration of the skin and high mortality rates in all age groups.

LEGISLATION

The disease was included in the Swedish Act of Epizootic diseases in 1999 (SFS 1999:657 with amendments) and is consequently notifiable on suspicion. Notification will then lead to investigations.

SURVEILLANCE

The purpose of the surveillance is to document freedom from PRRSV and to detect introduction of the virus before it is widespread in the population. Both detection of viral genome and antibodies against PRRSV are used in the surveillance. To detect antibodies against PRRSV a commercial ELISA-method (IDEXX PRRS X3 Ab Test, Idexx Laboratories) is used and presence of the viral genome is analysed using a PCR-method. Samples positive for PRRSV antibodies in the ELISA-test are analysed by an immunoperoxidase monolayer assay (IPMA) for confirmation.

Passive surveillance

Because PRRS is notifiable on clinical suspicion for both veterinarians and farmers, cases with suspect clinical signs will be investigated following notification to the Swedish Board of Agriculture. The investigation includes sampling of sick or dead animals and examination of the herd for presence of clinical signs and analyses of production results. During the investigation the farm is placed under restrictions.

In addition, analyses for the PRRSV genome with PCR are included in the enhanced passive surveillance of aborted fetuses.

Active surveillance

The active surveillance programme revised 2012 and put into effect in 2013, comprises field sampling of all Swedish nucleus herds, multiplying herds and sow pools twice a year. In addition, randomly selected production herds are sampled continuously at slaughter. In nucleus herds, multiplying herds and sow pools eight samples per herd are taken at each sampling occasion and at slaughter three samples per herd are collected.

The revised programme was designed to take into consideration an increased risk of introduction, the changes in the structure of the pig production and to keep the probability of freedom of PRRS on the same level as after demonstration of freedom after the outbreak in 2007. To achieve this, the programme is designed using a between-herd design prevalence of 0.5%, a within-herd design prevalence of 40% and a risk of introduction of 1 in 5 years.

RESULTS

Passive surveillance

Five investigations following clinical suspicion of PRRS were conducted during 2016. Reproductive failure, weak piglets, high piglet mortality and circulatory disorder in sows were the main clinical manifestations. Other epizootic diseases (African and classical swine fever, Aujeszky's disease) were investigated in parallel to PRRS. The number of animals sampled and the methods chosen varied depending on the nature of the suspicion in terms of clinical manifestation and how widespread the clinical signs were in the herd. Following sampling and testing, the herds were all declared negative for PRRSV.

Within the surveillance of aborted fetuses, 43 fetuses from 23 herds were examined for the PRRSV genome and all samples were negative.

Active surveillance

In 2016, 875 samples from 60 nucleus herds, multiplying herds and sow pools and 2,446 samples from the abattoir sampling were analysed. The samples from the abattoir sampling originated from 815 sampling occasions and each herd was as a rule sampled 1-2 times during the year. For comparison, the number of samples for the years since the PRRSV outbreak are given in Table 10.

Two investigations following positive samples were performed. They included, in addition to further sampling, examination of the herds for clinical signs of PRRS and assessment of production results. No clinical signs of PRRS were detected and all additional samples were negative for PRRS antibodies and the investigations concluded the positive samples to be singleton reactors and not due to infection with PRRS in the herds.

Taking the surveillance outcome from 2015 into account, the probability of freedom based on the surveillance during 2016, was >99%.

DISCUSSION

Before the outbreak of PRRS in 2007, the active surveillance programme was based on field sampling in all nucleus herds, multiplying herds, sow pools and 50 production herds once a year, usually clustered in time. This surveillance design had the drawback of being expensive despite having a low sensitivity and a risk of poor timeliness. After the outbreak, the surveillance was further developed employing continuous abattoir sampling and a more effective field sampling in nucleus herds, multiplying herds and sow pools to improve early detection of a PRRSV introduction and to increase the sensitivity of the surveillance. The evaluation of the programme in 2012 indicated that the probability of freedom and the sensitivity of surveillance were declining over time and the changes that were suggested aimed at breaking this trend. The main reasons for the declining probability of freedom were the decreasing number of samples and an irregular sampling frequency. During recent years, the Swedish pig industry has undergone substantial structural changes leading to a rapidly declining number of herds and extensive changes in the market and in the habits of farmers. These changes emphasise the need for continuous monitoring of surveillance performance over the year and a yearly evaluation of performance and design. The present design with continuous sampling and testing over the year in combination with the clinical surveillance increase the probability of early detection compared to the strategy used before the outbreak.

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Table 10: Number of samples and herds tested in the active PRRS surveillance 2008-2016 in relation to the number of registered swine herds

Year	Field sampling		Abattoir sampling		Total number of samples	Number of registered swine herds in Sweden ^A
	Number of samples	Corresponding number of sampled herds	Number of samples	Corresponding number of sampled herds		
2008	2,052	128	3,724	1,241	5,776	2,380
2009	1,106	69	2,712	904	3,818	2,027
2010	2,012	126	4,424	1,475	6,436	1,695
2011	1,240	78	2,308	770	3,548	1,515
2012	1,055	66	2,145	717	3,200	1,318
2013	1,024	64	1,548	516	2,572	1,281
2014	912	57	2,028	676	2,940	1,300
2015	824	52	2,382	521	3,206	1,228
2016	875	60	2,446	815	3,321	1,252

^A Sources: Yearbook of agricultural statistics 2009-2016; Sveriges Officiella Statistik - Statistiska Meddelanden JO 20 SM 1403

Psittacosis



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BACKGROUND

Psittacosis is caused by *Chlamydia psittaci*, an intracellular bacterium. In 1879, psittacosis was described for the first time when an outbreak of pneumonia associated with exposure to tropical pet birds was detected among Swiss patients. The organism was identified in the 1930s. Since then, outbreaks have been described worldwide.

The main reservoir is birds and the organism is excreted in faeces and nasal discharges. Birds may become carriers of the organism and shed it intermittently for years without any clinical signs. People acquire the infection mainly via inhalation of contaminated dust or through contact with infected birds. In birds, the infection is transmitted via contact, by ectoparasites or contaminated equipment. *C. psittaci* may persist in dry faecal material for months.

Control of psittacosis is very difficult. As the organism exists in both domestic and wild birds, eradication is impossible.

DISEASE

Animals

Birds commonly develop clinical signs when stressed or when their immune system is suppressed. Clinical signs in birds range from an asymptomatic infection to conjunctivitis, sneezing, pneumonia and generalised infection. Adult birds recover from the infection but mortality can be up to 90% among young birds.

Humans

In humans, the symptoms often include fever, headache, rash, myalgia, chills and upper or lower respiratory tract infection. The disease is usually mild or moderate, but can be severe especially in untreated elderly persons. Most human cases are sporadic, many infections are probably not diagnosed. The incubation period is usually around 10 days but can vary from 1 to 4 weeks.

LEGISLATION

Animals

C. psittaci is notifiable in animals according to SJVFS 2013:23.

Humans

Psittacosis has been a notifiable disease since 1969 according to the Communicable Disease Act (SFS 2004:168) with the amendments of SFS 2013:634.

SURVEILLANCE

Animals

Surveillance in animals is passive. Notification is based on detection of the organism by PCR targeting all members of the *Chlamydiaceae* family, including both genera of *Chlamydia* and *Chlamydophila*. Species identification can be performed by sequencing the PCR fragment.

Humans

The surveillance in humans is passive. For laboratory verification of the infection serology and PCR are the methods used.

RESULTS

Animals

In 2016, two domestic parrots, six wild birds and seven unspecified bird species were tested for *C. psittaci*. Four of the 15 tested animals had a positive result.

Humans

Psittacosis is mainly a domestic infection. Of the 20 cases reported during 2016 only 1 was infected abroad (in UK). 5 of the cases were women with a median age of 69. The men were between 31 and 80 years old with a median age of 67. A majority of the cases reported that they had been in contact with birds or bird droppings. For the remaining cases there were no obvious route of transmission. All cases were reported from the south of Sweden.

DISCUSSION

At present, *C. psittaci* does not occur in Swedish poultry. The organism is occasionally reported in captive birds but psittacosis is considered common in both captive birds and wild birds. Four birds tested positive for *C. psittaci*, but unfortunately it was not possible to know whether they were captive or wild birds, since they were all recorded as unspecified bird species.

In the 1980s around 100 human cases were reported each year. However, during the last decade the number of reported cases has decreased considerably.

One of the reasons for the decrease in the number of cases is believed to be changes in diagnostic methods. The methods used today are more accurate and many of the early cases are believed to be incorrectly reported as psittacosis.

Another reason that may have contributed to the decrease were amendments in hygiene requirements for pet stores. One of the new requirements were that imported birds had to be treated with prophylactic antibiotics to prevent infections.

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Q fever

BACKGROUND

Q fever is a zoonotic disease caused by the bacterium *Coxiella burnetii*. Because of its tolerance to heat, dryness and many disinfectants, the organism is difficult to eradicate. Cattle, sheep and goats are considered to be the main reservoirs of the organism, but pets such as dogs and cats may also become infected. The agent is shed through several routes, such as milk, foetal and vaginal fluids, faeces, urine and semen. *C. burnetii* has also been isolated from ticks.

Transmission to humans is mainly considered to be through inhalation of contaminated aerosols and dust. Therefore, contact with dusty animal products and environments, such as wool, hay and bedding material may pose a risk. Also, consumption of unpasteurised milk may be a risk to susceptible individuals. In humans, immunosuppression, predisposing valvular heart disease and pregnancy may increase susceptibility to Q fever.

Larger outbreaks of Q fever, when reported, are principally associated with small ruminants, whereas cattle appear to be the source of sporadic cases. In many countries, Q fever is seen as an occupational hazard for professionals in contact with domestic ruminants and their environments, such as farmers, veterinarians and abattoir workers.

The presence of *C. burnetii* in domestic animal populations in Sweden has been known since the early 1990s. The bacterium was first isolated from a sheep placenta in a herd on the isle of Gotland. In 2008/2009, a national survey of dairy cattle herds showed that 8% of the herds were antibody positive in bulk milk. There were large regional differences with the highest prevalence on the isles of Gotland and Öland (59% and 35%, respectively). In 2010, national surveys of sheep and dairy goat herds showed a very low prevalence of antibodies; 0.6% (n=518 herds) and 1.7% (n=58 herds), respectively. In addition, goat bulk milk was also analysed for detection of the agent and *C. burnetii* was not detected. In 2011, 80 sheep farms were investigated for the presence of the agent by analysing vaginal swab samples from sheep taken in conjunction with lambing without detecting the agent in any of the samples. The results supports that *C. burnetii* is a

rare pathogen in the Swedish sheep and goat populations. In a survey of 99 Swedish moose during 2008-2010 no positive samples were found, indicating that *C. burnetii* is rare also in this wild species.

In humans, only two domestic cases were reported in the 1980s and 1990s. During the same period, a serological survey in humans identified 28% of sheep farmers and 13% of veterinarians to be antibody positive, indicating a larger extent of the exposure. However, a prospective study on cases of endocarditis showed that only one of 329 patients had antibodies to *C. burnetii* indicating that chronic Q fever endocarditis is rare. Since Q fever became notifiable in humans in 2004, one to three cases have been reported annually until 2008, when an increase was observed. Only one case was classified as domestic during the period from 2004-2009. In 2010, the situation changed as eight of the totally 11 reported cases claimed to have been infected in Sweden. All these domestic cases were linked to a farm in southern Sweden, which was included in a national survey on dairy herds and where the bulk milk from the cows was shown to be antibody positive for *C. burnetii*. No active surveillance has been conducted after 2011.

DISEASE

Animals

Q fever in animals is usually asymptomatic but can also lead to reproductive failures such as abortions or still/weakborn calves. In herds where the agent has been proven to be present it should be determined whether any reproductive problems are due to Q fever or if there are other causes.

Humans

In humans the infection can vary from asymptomatic or flu-like illness to acute pneumonia. Liver complications and abortions can also occur. Most patients recover but some may develop a chronic illness. The incubation period varies depending on the number of organisms inhaled but is usually 2-3 weeks.

LEGISLATION

Animals

Q fever is a notifiable disease (SJVFS 2013:23). Notification of a primary case of Q fever in animals is

based on detection of the agent *C. burnetii* or increased antibody levels in paired samples.

Humans

Q fever has been notifiable according to the Communicable Disease Act since 2004 (SFS 2004:168) with the amendments of SFS 2013:634.

SURVEILLANCE

Animals

Surveillance for Q fever in animals is passive. Limited testing was done on cattle and yaks for export reasons. Blood samples from 41 cattle and 10 yaks were analysed for the presence of antibodies by complement fixation test or ELISA. Animals from two herds were tested for presence of antibodies in bulk milk or milk samples by ELISA.

Humans

The surveillance in humans is passive. For laboratory verification of the infection, serology and PCR are used.

RESULTS

Animals

Bulk milk samples and one individual milk sample from one cattle herd were positive for antibodies to Q fever. All other samples that were submitted for testing were negative.

Humans

Since the 1980s, few domestically acquired cases of Q fever have been reported apart from the cluster in 2010. Most reported cases have been infected in Mediterranean countries. In 2016, three

cases of Q fever, two male and one female were reported. Countries of infection were Spain, Greece and Azerbaijan.

During the period when Q fever has been a notifiable disease, only about 20% of the reported cases have been women. A similar difference in gender distribution has been described from other countries, but the cause of it is not clear.

DISCUSSION

After four years (2008-2011) of active surveillance for Q fever, as well as other related studies, the present surveillance in animals is passive. It is notable that awareness and concern with Q fever as a differential diagnosis has decreased. Due to the nature of the infection, this situation is not likely to change as long as the surveillance remains passive, i.e. dependent on the health or veterinary care seeking behaviour of individuals.

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Rabies

BACKGROUND

Rabies is caused by a lyssavirus in the family *Rhabdoviridae*, and can infect all warm-blooded animals. The disease occurs worldwide with some exceptions. Rabies is transmitted through contact with saliva, typically via animal bites. Most human cases are caused by bites from infected dogs. The reservoir animal species for rabies in endemic countries are most notably among carnivores of the family *Canidae*. In Europe, the reservoir species are red foxes and raccoon dogs.

Bats in Europe may carry another type of lyssavirus called European Bat Lyssavirus (EBLV), but not classical rabies. Sweden has been free from classical animal rabies since 1886. EBLV has never been isolated from bats in Sweden, but antibodies to EBLV have been detected in specimens from live bats suggesting that EBLV is present in Sweden.

Humans and animals

Rabies virus infects the central nervous system of humans and mammals. Early symptoms of rabies are nonspecific, consisting of fever, headache, and general malaise. As the disease progresses, neurological symptoms appear and may include: insomnia, severe anxiety, confusion, slight or partial paralysis, excitation, hallucinations, agitation, hypersalivation and difficulty in swallowing. The incubation period of rabies is usually 3-6 weeks, but may vary from five days to one year.

Not much is known about clinical signs of EBLV in infected bats. They may express weight loss, disorientation, lack of coordination, muscle spasms and aggression, but some infected bats may be normal in behaviour.

LEGISLATION

Animals

Rabies is included in the Swedish Act of Epizootic diseases (SFS 1999:657 with amendments) and is notifiable on suspicion. If rabies is suspected or confirmed, measures will be taken to combat the disease and to prevent further spread.

To prevent the introduction of rabies, dogs and cats must be rabies vaccinated before entering Sweden. In addition, depending on the country of origin, some must have their antibody titre tested.

The rules are set in SJVFS 2011:49 (with amendments of SJVFS 2014:47) and in the EU Regulation 576/2013.

Humans

Rabies in humans is notifiable according to the Communicable Disease Act (SFS 2004:168 with the amendments of SFS 2013:634).

SURVEILLANCE

Animals

Passive surveillance

Animals with clinical signs where rabies cannot be excluded, are tested on suspicion by fluorescent antibody test (FAT). In addition, enhanced passive surveillance for rabies in dead bats was performed using PCR on brain tissue.

Active surveillance

Illegally imported pets, from countries with endemic rabies, that are detected and euthanized are examined for rabies to exclude the possible spread of rabies in Sweden.

Humans

The surveillance in humans is passive.

RESULTS

Animals

One cat, one dog and one red fox were examined for rabies due to clinical suspicion. Furthermore, 57 bats were sent to the National veterinary Institute as part of the enhanced passive surveillance programme. Out of these, 34 bats were examined for rabies (Fig. 11); the other specimens were excluded due to bad condition. The bats were sent to the Swedish Museum of Natural History for species determination.

During 2016, 32 illegally introduced euthanized dogs and three cats were examined after decision by the Swedish Board of Agriculture. The diagnostic method used was PCR. None of the animals had presented clinical signs associated with rabies. All animals tested negative for rabies.

Humans

No human cases were reported during the year.

DISCUSSION

During the recent decades, two people have been hospitalised for rabies in Sweden. In 1974, a Swedish man fell ill after having been infected in India. In 2000, a woman fell ill after a visit to Thailand. Both patients had most probably been infected by rabid dogs. Since Sweden is free from classical rabies, the risk of acquiring the disease from Swedish animals is negligible. However, since 2004, there has been an increasing problem with illegal importation of pets, mostly dogs. Illegally imported dogs from endemic countries are probably the greatest threat to the rabies free status of Sweden. During 2014, SVA made a risk assessment on rabies. The results suggest that the probability of introducing rabies with illegally imported pets is very low, but not negligible. The results are similar to the results from 2005. The Board of Agriculture changed the risk management of illegally imported pets during 2015 which resulted in fewer euthanized dogs. Instead the dogs are kept under the owner's control. How this influences the overall risk of rabies in Sweden is not known.

Almost every year since 1998, an enhanced passive surveillance programme where dead bats are examined for the presence of rabies has been implemented. In addition, from 2008 to 2013 an active surveillance programme for EBLV was performed in different regions in Sweden.

Antibodies to EBLV have been detected in specimens from live Daubenton's bats as part of the active surveillance programme, suggesting that EBLV is present in Sweden. Daubenton's bats (*Myotis daubentonii*), associated with EBLV-2, are common and may be found from the south up to the county of Ångermanland in the north. Six other *Myotis* species may also be found in Sweden. The Serotine Bat (*Eptesicus serotinus*), associated with findings of EBLV-1 in Europe, is found in certain habitats in the south of Sweden. The Northern Bat (*Eptesicus nilssonii*), which is related to the Serotine Bat, is the most common bat in Sweden, and may be found all over the country. There are 19 different species of bats in Sweden, all insectivorous belonging to the family of *Vespertilionidae*.

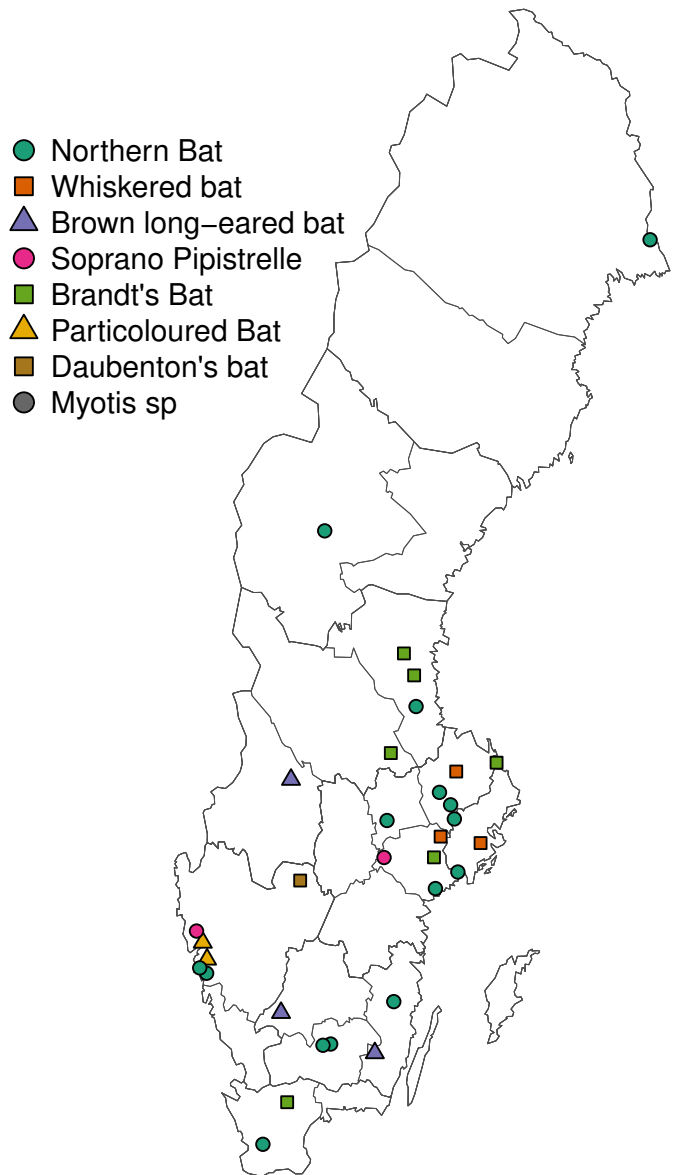


Figure 11: Geographical distribution of bats tested for rabies in 2016

Salmonellosis



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BACKGROUND

Salmonellosis is one of the most important bacterial zoonoses. The genus is divided into two species: *S. enterica* and *S. bongori*. Most *Salmonella* belong to *S. enterica* subspecies *enterica*. More than 2,500 different serovars belonging to this subspecies have been described. *Salmonella* can infect reptiles, all warm-blooded animals as well as humans. Humans are infected by contaminated food products of various types, through contact with infected animals, via person-to-person transmission or via a contaminated environment.

A severe domestic outbreak of *S. Typhimurium* in 1953 that involved more than 9,000 people prompted the need for a control programme for *Salmonella*. Since then, the strategy for control has been to prevent *Salmonella* in all parts of the production chain, from feed to food of animal origin. When Sweden joined the European Union in 1995, the Swedish *Salmonella* control programme was accepted. Sweden obtained additional guarantees that food products of animal origin from countries with a non-equivalent *Salmonella* status should be tested

for the presence of *Salmonella* before being placed on the Swedish market. These additional guarantees constitute an important safeguard to Swedish public health.

The past ten years, an average of 3,000 human cases of salmonellosis have been reported annually to the Public Health Agency of Sweden. A majority of these (70-80%) were infected abroad. The low proportion of domestic infections is unique to Sweden compared to many other countries. A few larger outbreaks have been reported, and the source is often imported food. The contribution to the human disease burden from domestic animals is very limited.

DISEASE

Animals

Infected animals are often asymptomatic. However, *Salmonella* can cause clinical illness with diarrhoea, abortions and fever, and even lead to death. In Sweden, clinical signs are frequently seen in cattle and horses, but infected pigs and poultry are most commonly asymptomatic.

Humans

Salmonella infects the gastrointestinal tract and causes an acute gastrointestinal illness. The symptoms can range from asymptomatic and mild to severe. The incubation period is typically between 1 and 3 days but can vary from 6 hours to 10 days. Most patients recover from the illness spontaneously but sequelae such as reactive arthritis occur in approximately 1-15% of the patients. Moreover, prolonged asymptomatic excretion of the pathogen is common.

LEGISLATION

Feed

Control of animal feed is an integrated and essential part of the control programme for *Salmonella* at farm level. The feed business operator is responsible for producing *Salmonella*-free feed. Poultry feed must be heat treated according to the legislation. A major part of cattle and pig feed is also heat-treated. The production of feed is supervised by the Swedish Board of Agriculture which carries out announced and unannounced inspections at feed mills. The control of *Salmonella* in feed is regulated in national legislation (SJVFS 2006:81) as well as in an EU regulation (Commission Regulation (EU) No142/2011).

Animals

Investigation is required upon clinical suspicion of salmonellosis and any finding of *Salmonella*, regardless of serovar, is notifiable and action is taken to eliminate the infection or contamination. Vaccination is not used in Sweden. The *Salmonella* control programme is governed by the Swedish Act on Zoonoses (SFS 1999:658) and its regulations. The aim of the programme is that animals sent for slaughter and animal products should be free from *Salmonella*.

Food

Any finding of *Salmonella* in food is notifiable and a contaminated food product is considered unfit for human consumption. However there is one exception, which is *Salmonella diarizonae* serovar 61:(k):1,5(7) in sheep meat which is not considered to be of public health importance, (LIVFS 2005:20 with amendments).

Humans

Salmonellosis in humans is notifiable according to the Communicable Disease Act (SFS 2004:168 with

amendments, SFS 2013:634).

SURVEILLANCE

Feed

In the control programme for feed, the emphasis is on control of feed raw materials, the heat treatment process and preventive measures for preventing re-contamination of heat-treated feed. Suspected feed-borne infections are also investigated.

Surveillance of feed raw materials

Raw materials are the most important risk factor in feed production. In the domestic legislation, feed materials are classified according to the empirical risk of being contaminated, and high-risk feed materials have to be tested negative for *Salmonella* contamination before being used for feed production. All consignments of intra-community traded or imported feed materials classified as a risk, have to be sampled for *Salmonella*. The sampling plan is designed to detect a *Salmonella* contamination in 5% of the batch with 95% probability.

Surveillance of feed mills

The purpose of the surveillance is to ensure the absence of *Salmonella* in the production lines as well as in the feed mill environment. A safety management system is applied in the processing line according to HACCP (Hazard Analysis and Critical Control Points). The management system covers a number of specific GMP (Good Manufacturing Practices) requirements, according to Swedish legislation. A minimum of five samples from feed mills manufacturing compound feeding stuffs for poultry and a minimum of two samples from those manufacturing compound feeding stuffs for other food-producing animals must be collected in the processing line on a weekly basis. These samples are analysed at the National Veterinary Institute (using MSRV, amendment to ISO 6579:2002 Draft 251004) and any finding of *Salmonella* is reported to the Swedish Board of Agriculture. The feed manufacturers also take additional samples from the processing line and the feed mill environment as part of their own process quality control.

Food

Control of *Salmonella* is an important part of in-house quality control programmes in most food enterprises in Sweden. All findings must be reported to the competent authority.

Official sampling by local authorities at food enterprises, other than abattoirs and cutting plants, is at a level of approximately 1,000 samples per year and samples are analysed mainly using NMKL (nr 71:1999) and Vidas-SLM methods.

Surveillance at abattoirs and cutting plants

According to the Swedish *Salmonella* control programme, samples from intestinal lymph nodes and swabs from carcasses are taken from cattle and swine and neck skin samples are taken from slaughtered poultry. Sampling is proportional to slaughtering capacity. Altogether, approximately 20,000 samples from cattle, adult swine, fattening pigs and poultry are collected annually at abattoirs.

At red meat cutting plants, approximately 5,000 samples are taken annually from crushed meat and meat scrapings and approximately 900 samples are taken in poultry meat cutting plants. The samples are analysed by regional laboratories using the current edition of the NMKL (nr 71:1999) method, with the exception of approximately 700 samples analysed by Vidas-SLM.

Control in food-producing animals

Control in poultry

The programme comprises a compulsory part and a voluntary part. All poultry species are included in the compulsory part, which sets the rules for mandatory sampling.

Compulsory programme - poultry

All breeding flocks with more than 250 birds are tested (Table 11). Grandparents of *Gallus gallus* broilers are imported as day-old chicks. Laying hens, turkeys, geese and ducks are imported as parents. Samples consist of sock samples taken from all parts of the house where the birds are kept. From rearing flocks, two pairs of sock samples are taken and pooled into one whereas five pairs pooled to two are taken from production flocks of breeders.

All holdings selling eggs for consumption are sampled (Table 11). All poultry flocks having more than 500 birds, irrespective of species, are tested 1-2 weeks before slaughter. In practice, all poultry flocks are tested prior to slaughter. The results must be available before slaughter.

The producers pay the costs for laboratory analyses and the visits to the farms. Only accredited laboratories are allowed to perform the analyses. The laboratory sends the test results to the County Veterinary Officer on a quarterly basis. According to

regulations, the County Veterinary Officer has to send a report on the test results of all poultry holdings to the Swedish Board of Agriculture once a year.

Voluntary programme - poultry

The voluntary preventive programme includes all-in all-out production, hygienic measures and a high standard for poultry houses, such as hygienic barriers between the clean and unclean parts. Purchases of animals may only occur from holdings affiliated to the voluntary programme and only heat-treated feed is allowed. The poultry houses must be cleaned and disinfected before introduction of a new flock. The broiler producer has to make an application to be accepted into the voluntary programme. An official veterinarian inspects the housing regularly. The producers affiliated to the voluntary programme receive higher compensation in case of *Salmonella*. All broiler producers belonging to the Swedish Poultry Association are affiliated to the voluntary programme (approximately 99% of the slaughtered broilers). The voluntary programme has been in place for more than 40 years.

Control in cattle and pig herds

The programme includes a compulsory and a voluntary part.

The compulsory part consists of annual faecal sampling from breeding pig herds and gilt-producing herds and twice-a-year sampling from sow pools. There is no compulsory testing in cattle. *Salmonella* is also tested for in conjunction with post-mortem investigations if an infection is suspected by macroscopic findings. All imported animals are sampled. On clinical suspicion, herds or single animals should be tested for *Salmonella*.

The voluntary programme is a preventive hygienic programme aiming at decreasing the risk of *Salmonella*. Holdings affiliated to the programme receive higher compensation in case of positive findings. The majority of all breeding herds and many of the large dairy herds are affiliated to the programme. In addition, affiliated holdings are entitled to apply for a commercial *Salmonella* insurance.

Control in other animals

Animals are tested for *Salmonella* at suspicion or as part of trace-back investigations. Wild animals necropsied at the National Veterinary Institute are tested for *Salmonella* at suspicion.

All samples from animals (poultry, cattle and

pigs and other animals) are analysed using the MSRV (EN-ISO 6579:2002/A1: 2007: Amendment 1: Annex D) method.

Humans

Salmonella infection is notifiable in humans. A trace back investigation is completed for all domestic cases of *Salmonella*. All isolates sent to the Public Health Agency of Sweden are analysed according to the guidelines of the WHO Collaborating Centre for Reference and Research on *Salmonella*. Institute Pasteur, Paris, France Grimont, P. A. D. and Weill, F-X, 2007.

MEASURES IN CASE OF POSITIVE FINDINGS Isolates

All suspected index isolates of *Salmonella* from non-human sources are sent to the National Veterinary Institute for confirmation, serotyping, resistance testing, and further typing. Index isolates of *Salmonella* from domestic human cases are sent to the Public Health Agency of Sweden for serotyping, phage typing and further molecular typing. A subset of isolates from travel-associated cases are also typed. Already in 2013, phage typing of *S. Typhimurium* was completely replaced by MLVA (multi-locus variable number tandem repeat analysis). During 2016 MLVA was introduced also for *S. Enteritidis*.

Feed

Findings of *Salmonella* in intra-community traded or imported feed materials and compound feeds are reported in the Rapid Alert System for Food and Feed (RASFF). Measures are always taken when *Salmonella* is detected in feed samples. *Salmonella* positive feed materials are usually treated with organic acids. After acid treatment the feed material has to be re-tested negative before use in feed production. Finished feed containing *Salmonella* has to be withdrawn from the market. Extended sampling and cleaning are done in the production line if *Salmonella* is detected in the weekly surveillance. If *Salmonella* is found before heat treatment the contaminated part of the production line is thoroughly cleaned and disinfected, usually by dry cleaning, followed by disinfection. If *Salmonella* is found after heat treatment, the feed mill has to be thoroughly cleaned and disinfected. Environmental sampling must show negative results before production is resumed.

Animals

If *Salmonella* is suspected in an animal, a veterinarian is obligated to take samples and implement measures to prevent further transmission. When *Salmonella* is isolated at a laboratory the laboratory must notify the Swedish Board of Agriculture and the County Veterinary Officer. When *Salmonella* is detected in a food-producing animal, the County Veterinary Officer informs the official veterinarian at the abattoir. When relevant, other persons are informed before confirmation.

When *Salmonella* is confirmed on a farm, the holding is put under restrictions, an epidemiological investigation is performed and a plan to eradicate *Salmonella* from the holding is defined. Animal movements to and from the holding are stopped.

All *Salmonella* positive poultry flocks are destroyed irrespective of serovar. The poultry house and all possible contaminated areas are thoroughly cleaned and disinfected. Before introduction of new birds, all environmental samples must be negative for *Salmonella*.

In pigs and cattle, a combination of partial herd depopulation and hygienic measures controlled by repeated sampling is usually practised. Cattle herds that are under restrictions for *Salmonella* are monitored by a combination of serological and bacteriological testing. Hygienic measures can include reducing the number of animals, control of animal feed and manure management on the farm and reduction of *Salmonella* in the environment by cleaning and disinfection. Animals from restricted herds may be slaughtered after sampling with negative results. The restrictions are lifted when the cleaning and disinfection have been completed and *Salmonella* cannot be detected by culture from whole-herd sampling at two occasions performed four weeks apart. If *Salmonella* is detected in companion animals advice is given to the owners. If *Salmonella* is detected in horses, the stables and/or the paddocks at risk are put under restrictions and follow up investigations are performed on the positive horse(s).

Food

Food products contaminated with *Salmonella* are considered unfit for human consumption. Products released on the market will be withdrawn and contaminated products will be destroyed or sent for special treatment to eliminate the *Salmonella* bacteria. However there is one exception which is *Salmonella diarizonae* serovar 61:(k):1,5(7) in

sheep meat, which is not considered to be of public health importance, (§§ 30a-30b, LIVFS 2005:20 with amendments).

Findings in imported consignments are reported in the RASFF-system and the consignments will be returned to the country of origin, destroyed or sent for special treatment as applicable. RASFF is also used for informing about contaminated Swedish food products released on the EU-market.

In food businesses where *Salmonella* has been detected, appropriate follow-up measures will be applied, such as careful cleaning and disinfection and environmental sampling.

RESULTS

Feed

Eleven major feed mills produce approximately 95% of the feed for food producing animals. In the weekly surveillance of feed mills, 8,212 samples were analysed for *Salmonella* with 17 samples (0.2%) being positive. Eleven serovars were detected; *S. Havana* was the most common (n = 5) (Table 12).

In addition, *Salmonella* was detected in 20 out of 1,547 analysed batches from feed materials of vegetable origin. The most common serovar was *S. Mbandaka* (n=10). *Salmonella* was detected in 1 out of 1,264 batches from feed materials of animal origin and from pet food.

Animals

Poultry

Salmonella was detected in 9 (0.24%) of 3,680 broiler flocks tested in routine sampling before slaughter (Table 13). In addition, *S. Typhimurium* was detected in one parent flock (Table 13 and Figure 12). Also, *Salmonella* was detected in four (0.59%) of 673 flocks of layers. *Salmonella* was also detected in one flock of geese. *Salmonella* was not detected in any flocks of turkeys or ducks.

Cattle

In total, *Salmonella* was detected in one new herd in 2016 (Table 14);

By the end of 2016, nine cattle herds were under restriction for *Salmonella*.

Salmonella was isolated from four (0.11%) of 3,627 mesenteric lymph nodes from cattle at slaughter (Table 15 and Figures 13 and 14).

Pigs

In 2016, *Salmonella* was not detected in any pig herd (Figure 15).

Salmonella was detected from one (0.06%) of 1,548 lymph node samples taken from adult pigs and from two (0.08%) of 2,364 lymph node samples from fattening pigs (Table 15, Figures 13 and 14).

Other animals

In 2016, *Salmonella* was detected in 489 cats (Table 16), which is more than previously reported. Of the 951 samples submitted for analysis, 54.2% yielded *Salmonella*. Findings of *Salmonella* in cats were geographically clustered: 66.7% of the findings were from the counties of Stockholm, Uppsala, Dalarna and Västra Götaland. Most (82.4%) of these cases were reported in February and March. All of the 145 serotyped cat isolates belonged to the serovar Typhimurium.

Also, *Salmonella* was detected in six dogs, 33 wild birds (mainly passerine) and two hedgehogs (Table 16).

Food

In the Swedish *Salmonella* control programme, *Salmonella* was detected from two of the 3,957 pig carcass swab samples but not from any of the 3,661 swab samples from cattle (Table 15). *Salmonella* was not isolated from any of the 4,288 poultry neck skin samples. All the 908 samples of poultry meat and the 4,955 samples of red meat taken at cutting plants were negatively tested for *Salmonella* (Table 15 and Figures 13 and 14).

Available results from official sampling by local authorities at food enterprises showed that 741 samples for *Salmonella* were taken for reasons other than the *Salmonella* control programmes. Six of these 741 samples were positive. Five of these were meat products from either pig, bovine animals or unspecified and one was from raw meat from broilers.

Humans

In 2016, a total of 2,246 cases of salmonellosis were reported, compared to 2,291 cases in 2015 (Figure 16). Domestic cases decreased by 6% from 688 cases in 2015 to 645 cases in 2016, giving an incidence of 6.45 cases per 100,000 inhabitants.

A majority of the cases (n= 1,594, 71%) were infected abroad. Since 2008, a steep decrease in the number of travel-associated cases has been noted, despite an increase in international travel. Travel-associated cases have decreased since the early

2000s. The observed decrease has been most apparent among those travelling in Europe. As in previous years, *Salmonella* infection was most commonly acquired in Thailand (396 cases) followed by Turkey (151). The number of cases infected in Greece increased from 47 to 131 whereas cases infected in Egypt decreased from 58 to 16.

Among the domestic cases, the median age was 41 years (0-90 years). Children below 10 years of age accounted for 400 of all reported cases (both the domestic and the travel-related cases). Among domestic cases 48% were men. Among travel-related cases 53% were men.

Of the isolates from domestic cases, 91 % were serotyped compared to 13 % of the travel-associated cases. The most common serotype was *S. Typhimurium* (22 %) and *S. Enteritidis* (22%) followed by monophasic *S. Typhimurium* (17 %). Of the domestic cases of *S. Typhimurium*, MLVA profile 3-15-N-N-311 (26 cases) was the most common, followed by 2-13-3-N-212 (12 cases). MLVA profile 3-12-8-N-211(43 cases) and 3-13-9-N-211 (16 cases) were most common among domestic isolates of monophasic *S. Typhimurium* and MLVA-profile 2-9-7-3-2 and 2-10-7-3-2 (11 and 10 cases respectively) was the most common among domestic isolates of *S. Enteritidis*.

A clear seasonal variation of domestic salmonellosis was observed with most cases during the summer months. Most travel-associated cases of salmonellosis are normally reported from January to March when travelling to warmer destinations is common. Also, a clear peak travel-associated cases is usually observed during the summer months when many people have vacation. These two seasonal peaks were also observed in 2016.

During 2016 the Public Health Agency was involved in the investigation of 8 outbreaks of salmonella, of which one was part of a European wide investigation of *S. Enteritidis* linked to Polish egg. The largest domestic outbreak of 46 cases was caused by monophasic *S. Typhimurium* with MLVA-profile 3-12-8-N-211 and 3-12-9-N-211. The outbreak affected 12 counties in Sweden during March and April. An epidemiological investigation pointed out a specific salami product as the common exposure among cases. The same strain was identified in the product from cases and from unopened packages, which led to recall of the product. Between January and March, 12 cases of *S. Typhimurium* with MLVA-profile 2-13-3-N-212 were identified in notified cases at the

Public Health Agency of Sweden. During the same time the National Veterinary Institute identified an increase of the same strain among wild birds and cats. Seven of the human cases reported contact with cats.

DISCUSSION

The low proportion of domestic human infections is unique to Sweden, Norway and Finland when compared to most European countries. In order to trace and further control the sources of infection it is important that both the total incidence and domestic incidence in humans continue to be reported. The total notified incidence in 2016, 22.5 cases per 100,000 inhabitants, is considerably higher than the domestic incidence of 6.5 cases per 100,000 inhabitants. The Swedish situation with few domestic human cases reflects the low *Salmonella* burden in domestic animals and food.

In the feed sector, data from 2016 showed that a number of different serovars were isolated in the weekly surveillance of feed mills where *S. Havana* was the most common (n=5). More or less all the findings were in the feed material intake area in a number of different feed mills. This illustrates the importance to handle feed materials in a proper way even if the feed materials have been tested negative for *Salmonella* contamination.

Salmonella was detected in nine broiler flocks, in four flocks of layers and in one parent flock of broilers. These flocks originated from 11 holdings. In 2016, two separate outbreaks of *S. Typhimurium* were traced to a hatchery. In late 2015, an outbreak of *S. Typhimurium* of MLVA pattern 2-13-12-10-212 traced to a hatchery, was detected and continued in early 2016 infecting thirteen flocks in eight broiler holdings. Two of these holdings had problems with recurrent infections in consecutive flocks. In autumn of 2016, *S. Typhimurium* of MLVA pattern 2-13-17-10-212 traced to another hatchery led to an infection in one Swedish broiler flock. In addition, two layer holdings had problems with persistent *Salmonella* infections. These problems highlight a need for more stringent routines in cleaning and longer empty periods between rounds of flocks.

In 2012, *Salmonella* Dublin was detected for the first time in decades in cattle herds in the county of Skåne. Altogether, 13 infected herds were detected in 2012-2015. All but one of them are located within a radius of 10 km, in a cattle dense area of Skåne. The only infected herd outside this region

had purchased cattle from one of these herds. No newly infected herds were detected during 2016 and at the end of the year, only five herds remained under restrictions, thus the outbreak may reasonably be considered to be in decline. Except this declining outbreak there was one newly detected cattle herd, infected with *S. Typhimurium*.

In order to present a context for the history of *Salmonella* Dublin in Sweden, data was obtained for the period 1958-1967 (Robertsson, 1985) (Fig. 17). This indicates that *Salmonella* Dublin did not become dominant in Sweden until a dramatic rise in the proportion of positive herds in 1963, when 102 cattle herds were detected with this serotype that still today is a challenge for the industry.

In 2016, *Salmonella* was not detected in any pig herd (Fig. 15). This is consistent with the low incidence of *Salmonella* in pigs in previous years. However, the decrease in the number of pig herds in Sweden during the last few years may also play a role in the low incidence.

In 2014, a new laboratory was chosen to perform *Salmonella* analyses within the part of the control programme that pertains to testing of samples from abattoirs and cutting plants. This laboratory was accredited for *Salmonella*, but, in fact, had only a limited experience with the bacterium. In 2014, *Salmonella* was not detected in any of the samples taken at the abattoirs or cutting plants. The National Reference Laboratory (NRL) for *Salmonella* and the National Food Agency of Sweden inspected the laboratory and found that the analytical methods and laboratory routines needed improvement. Unfortunately, problems with this laboratory continued in 2015 and 2016, with laboratory contamination and decreased performance. Thus, the results from the control programme from 2014 and 2015 are not fully reliable. Since May 2016, a new laboratory is in charge of the analyses.

Reported domestic human cases of *Salmonella* vary from year to year depending on the number of outbreaks. In 2016, the total number of notified human cases was almost the same as in 2015, but still at a lower level compared to previous years. The largest decrease over the past ten years was seen for the travel-associated cases, especially from European countries. This decrease in *Salmonella* cases has been seen in countries throughout the EU and is considered to be the result of the successful implementation of harmonised *Salmonella* control programmes in poultry across the union.

Thailand is the most common country for travel-associated salmonellosis, although the number of cases has decreased in the past years. However, it is still necessary to inform travellers about the risks of contracting *Salmonella* and other infectious diseases in order to further decrease the incidence. Also, information on how to prevent secondary transmission to other persons, to the environment and to animals when returning back to Sweden is crucial.

Routine MLVA typing and comparison of *S. Typhimurium* isolates from humans, animals, food, feed and the environment has proved to be a useful tool to detect clusters and outbreaks.

The Swedish *Salmonella* control programme has been in place for decades and resulted in a very low *Salmonella* burden in domestic animals (Figures 17, 15 and 18). However, the programme is costly and could be modernised. The Swedish Board of Agriculture, the National Food Agency, Public Health Agency of Sweden, the National Board of Health and Welfare and the National Veterinary Institute have jointly published a common national strategy for the control and monitoring of *Salmonella* for the entire chain from animal feed to humans. The strategy includes goals and proposals for important actions to achieve goals, including how the control programme should be made more cost effective.

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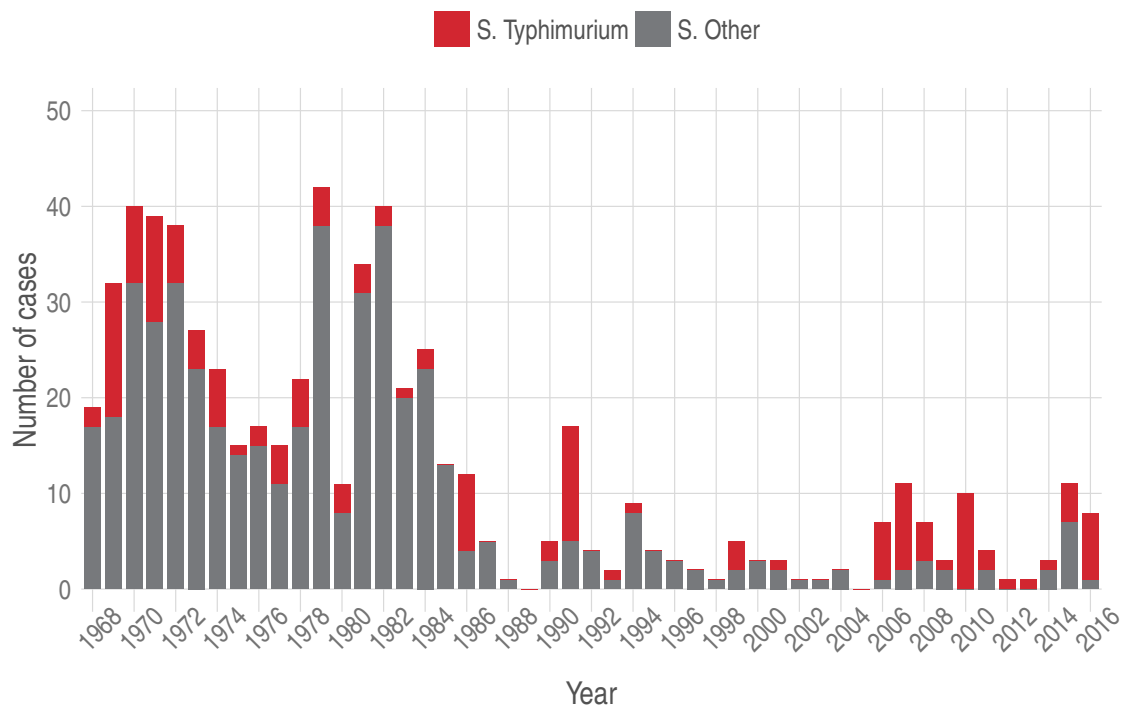


Figure 12: Frequency of notifications of *Salmonella* in broiler holdings during 1968-2016, breeding flocks included.

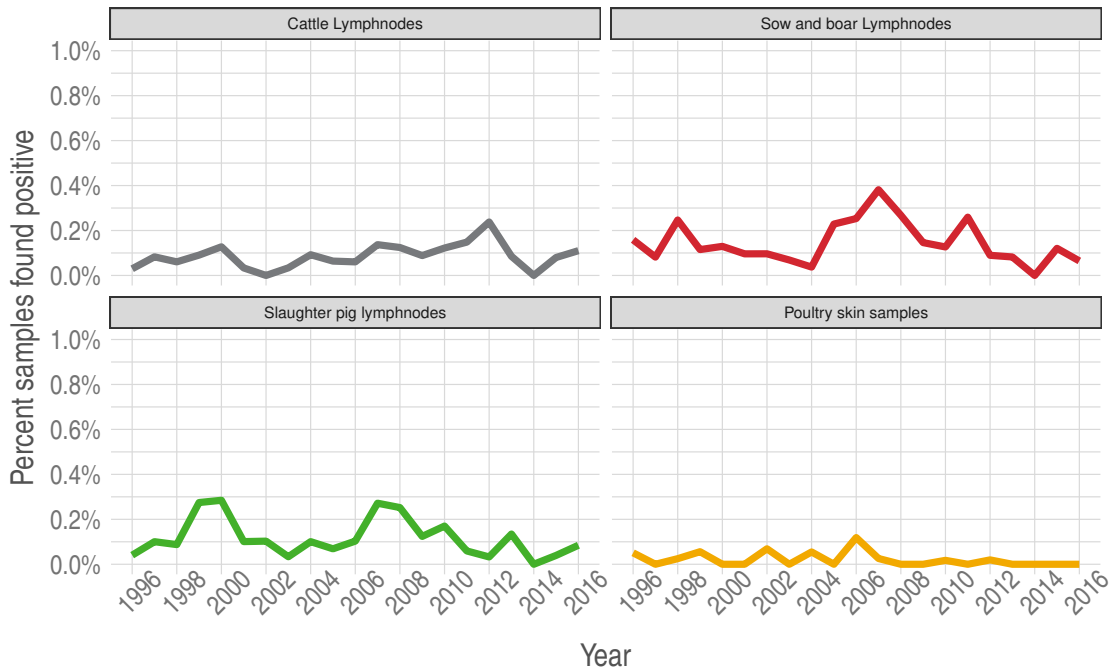


Figure 13: *Salmonella* found in lymph node samples from cattle, sows and boars and fattening pigs sampled at major slaughterhouses as well as neck skin samples from poultry at all slaughterhouses.

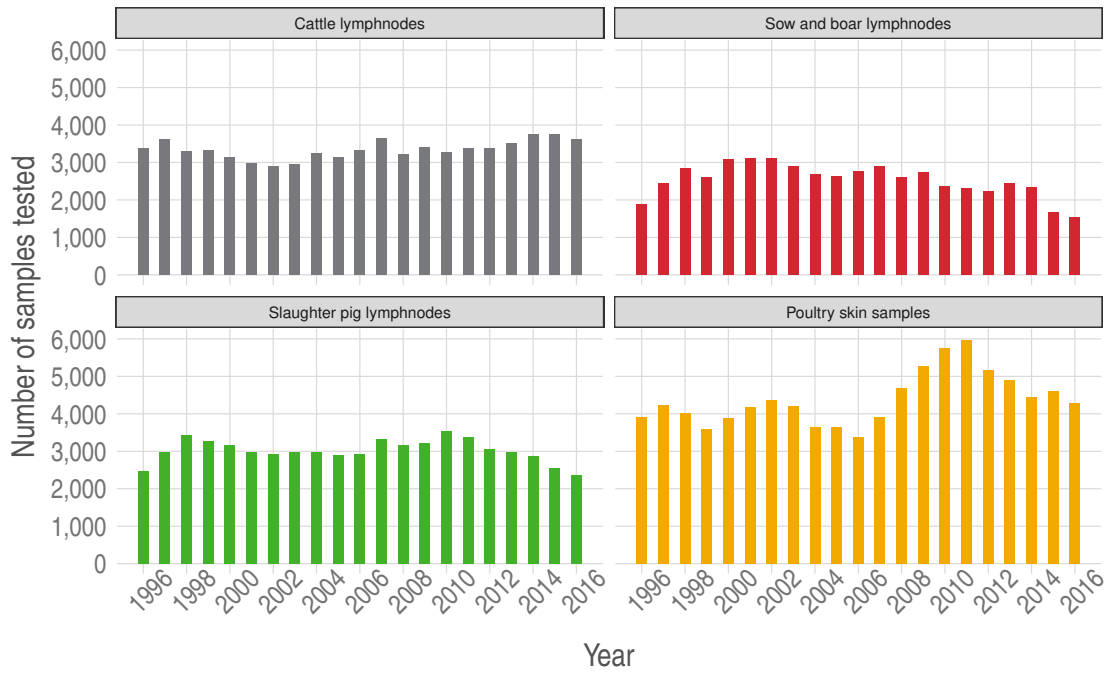


Figure 14: The number of lymph node samples from cattle, sows and boars and fattening pigs sampled at major abattoirs as well as the number of neck skin samples from poultry sampled at all abattoirs.

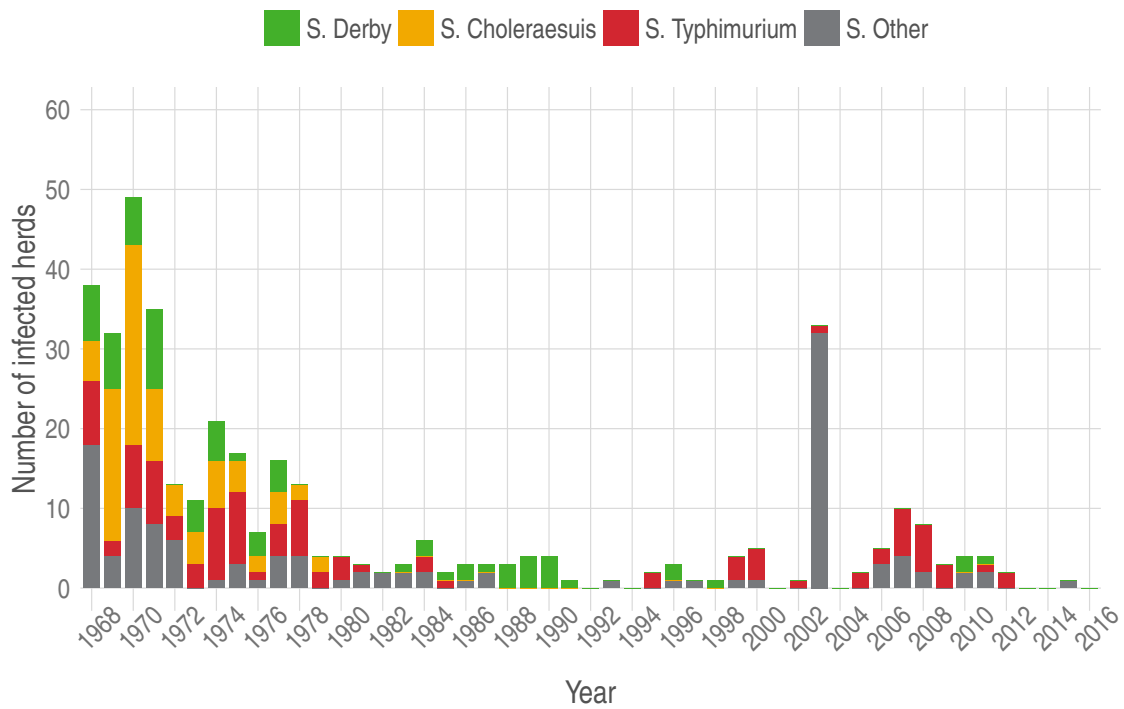


Figure 15: Frequency of notifications of *Salmonella* in swine herds during 1968-2016. In 2016, *Salmonella* was not detected in any herd.

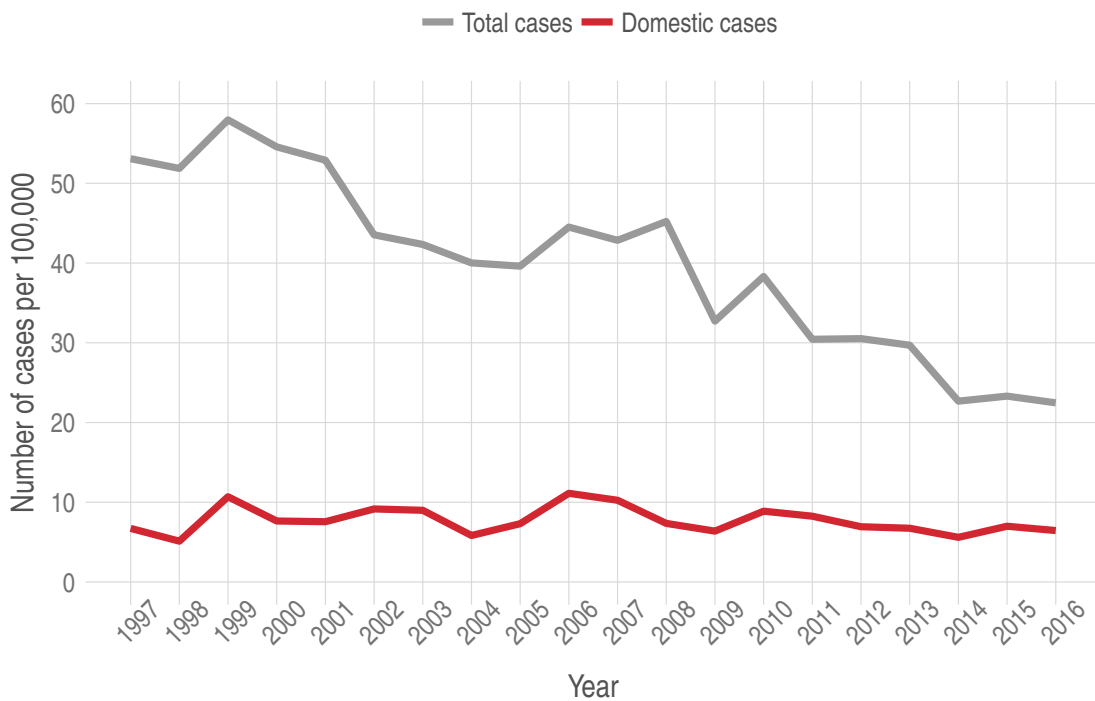


Figure 16: Notified incidence (per 100,000) of human salmonellosis in Sweden, 1997-2016.

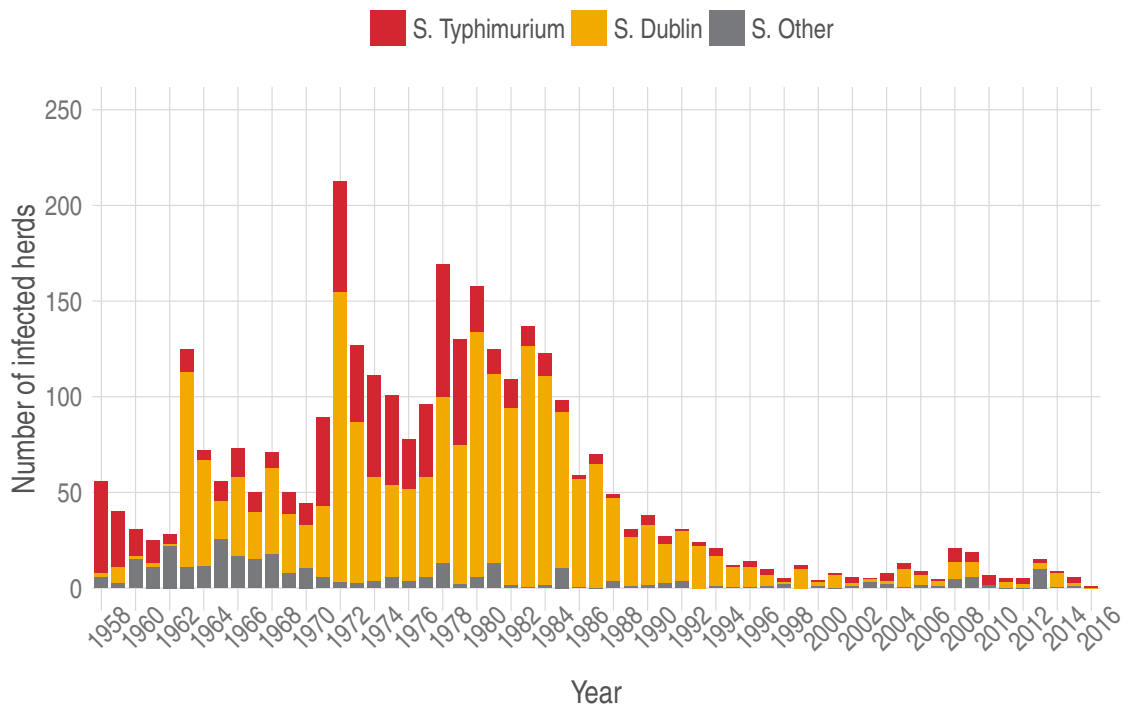


Figure 17: Frequency of notifications of *Salmonella* in Swedish cattle herds during 1958-2016. Data from 1958 through 1967 is extracted from a graph presented by J.Å. Robertsson (1985).

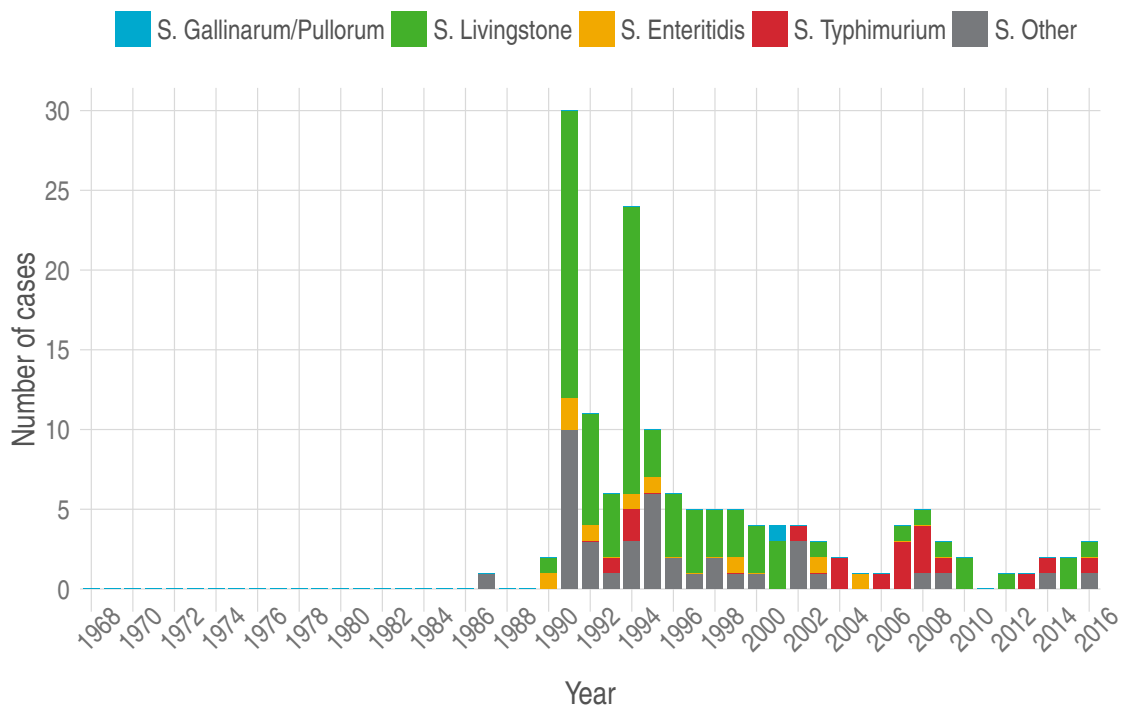


Figure 18: Frequency of notifications of *Salmonella* in layer holdings during 1968-2016.

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Table 11: Sampling scheme of poultry

Category of poultry	Sampling frequency	Sample type	Sampling before slaughter	Official veterinarian
Breeders in rearing	1 d, 4 weeks, 2 weeks prior to rearing or moving	2 pairs sock samples	14 d before slaughter	Once a year
Breeders in production	every 2 nd week	5 pairs sock samples	14 d before slaughter	3 times under production
Layers in rearing	2 weeks prior to moving	2 pairs sock samples or 2 faecal samples of 75 g	14 d before slaughter	Once a year
Layers in production	every 15 th week (start at 22-26 weeks)	2 pairs sock samples or 2 faecal samples of 75 g	14 d before slaughter	Once a year
Poultry for meat production (all species)		2 pairs sock samples or 2 faecal samples of 75 g	14 d before slaughter	Once a year

Table 12: Serotypes of *Salmonella* isolated in feed control in 2016.

Serotype	Feed material of animal origin ^A	Pet food	Feed material of oil seed origin ^B	Feed material of cereal grain origin	Process control feed mills	Process control rapeseed crushing plant
S. Amsterdam	-	-	-	-	1	-
S. Duesseldorf	-	-	-	-	1	-
S. Havana	-	-	-	-	5	-
S. Kedougou	-	-	1	-	2	-
S. Lexington	-	-	-	-	1	-
S. Livingstone	-	-	-	-	1	-
S. Mbandaka	-	-	10	-	2	-
S. Nyborg	-	-	1	-	-	-
S. Oranienburg	-	-	-	-	1	-
S. Senftenberg	-	-	8	-	1	-
S. Tennessee	-	-	1	-	1	-
S. Thompson	-	1	-	-	-	-
S. Typhimurium	-	-	-	-	1	-
<i>S. enterica</i> subspecies <i>enterica</i>	-	-	1	-	-	-
Total Positive	0	1	20 ^C	0	17	0
Total number of samples	1,065	199	1,017	461	8,212	816

^A Meat and bone meal, fish meal, greaves, bone meal, protein meal, meat meal, blood products, milk products, egg products and poultry offal meal.

^B Derived from palm kernel, rape seed, soya bean, linseed, peanut and sunflower seed.

^C In two of the units positive for *Salmonella*, two different serotypes were found in each unit.

Table 13: Results from *Salmonella* control programme in poultry flocks

Animal species	Production type	Production stage	No. flocks tested	No. positives	Percentage	Serotype
<i>Gallus gallus</i>	Meat production	Adult Grand Parent	22	0	0.00%	
<i>Gallus gallus</i>	Meat production	Adult Parent	120	1	0.83%	S. Typhimurium
<i>Gallus gallus</i>	Meat production	Production	3,680	9	0.24%	See footnote ^A
Turkeys	Meat production	Adult Parent	3	0	0.00%	
Turkeys	Meat production	Production	182	0	0.00%	
<i>Gallus gallus</i>	Egg production	Adult Parent	17	0	0.00%	
<i>Gallus gallus</i>	Egg production	Production	673	4	0.59%	See footnote ^B
Geese	Meat production	Production	24	1	4.17%	S. Typhimurium
Ducks	Meat production	Production	16	0	0.00%	

^A S. Mbandaka (n=1), S. Typhimurium (n=8)

^A S. Livingstone (n=1), S. Cerro (n=2), S. Typhimurium (n=1)

Table 14: Cattle herds under restriction for *Salmonella* infection in 2016

Primary serotype	Restricted since	Restrictions lifted	Reason for sampling
S. Aarhus	2015	-	Necropsy
S. Dublin	2012	2016	Trace-back
S. Dublin	2012	-	Necropsy
S. Dublin	2013	-	Necropsy
S. Dublin	2014	2016	Necropsy
S. Dublin	2014	2016	Trace-back
S. Dublin	2014	-	Trace-back
S. Dublin	2014	-	Trace-back
S. Dublin	2015	-	Necropsy
S. Dublin	2015	2016	Faecal sample from a diseased calf
S. Typhimurium	2015	-	Trace-back after a human case
S. Typhimurium	2015	-	Trace-back
S. Typhimurium	2015	-	Necropsy
S. Typhimurium	2016	2016	Abattoir sampling control programme

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Table 15: Results from the *Salmonella* control programme at slaughterhouses and cutting plants in 2016

Animal species	Sample type	No. samples	Positive	Percent Positive	Serotypes
Cattle	Lymph node	3,627	4	0.11%	S. Dublin, S. Duesseldorf, S. Typhimurium
	Carcass swab	3,661	0	0.00%	
Breeding swine	Lymph node	1,548	1	0.06%	S. Typhimurium
	Carcass swab	1,624	1	0.06%	S. Typhimurium
Slaughter swine	Lymph node	2,364	2	0.08%	S. Typhimurium
	Carcass swab	2,333	1	0.04%	S. Typhimurium
Cattle and swine	Meat scrapings	4,955	0	0.00%	
Poultry	Neck skin	4,288	0	0.00%	
	Meat scrapings	908	0	0.00%	

Table 16: Reported cases of *Salmonella* in cats, dogs, sheep, hedgehogs and wild birds in 2016

Serotype	Cats	Dogs	Sheep	Hedgehogs	Wild birds
S. Agona	-	1	-	-	-
S. Enteritidis	-	-	-	1	-
S. Fulica	-	-	-	1	-
S. Indiana	-	1	-	-	-
S. Mbandaka	-	1	-	-	-
S. Typhimurium	145	6	-	-	31
<i>Salmonella enterica</i> sp <i>diarizonae</i> =61:-1,5	-	-	3	-	-
<i>Salmonella enterica</i> sp <i>enterica</i> (I) = 4,5:-1,5	-	-	-	-	2
<i>Salmonella</i> , not serotyped	344	-	-	-	-
Total	489	9	3	2	33

Swine vesicular disease

BACKGROUND

Swine vesicular disease (SVD) is caused by a porcine enterovirus closely related to human Coxsackie B5 virus but is a disease that only affects pigs. The first report of SVD in pigs was from Italy in 1966 and the disease has since then been reported in several European countries as well as Japan and China. Today, SVD is present in Italy and sporadic outbreaks have been reported from Portugal. The route of transmission is mainly by direct contact between infected and non-infected animals and by feed contaminated with SVD virus.

DISEASE

Infection with SVD virus can lead to fever and blisters on the snout, tongue, teats and coronary bands. The similarity of these clinical signs with foot and mouth disease (FMD) is the reason this disease is monitored and controlled in countries free from FMD. Most infections with SVD virus are very mild or subclinical.

LEGISLATION

SVD is included in the Swedish Act of Epizootic diseases (SFS 1999:657 with amendments) and the control of the disease is regulated in detail through EU-directives.

SURVEILLANCE

The purpose of the surveillance activities is to document freedom from SVD in the Swedish pig population and to contribute to the maintenance of disease freedom. The National Veterinary Institute is responsible for sample selection, sample analysis and reporting to the Swedish Board of Agriculture.

The serological analyses of SVD antibodies on surveillance samples are performed using ELISA and positive results are confirmed with a serum neutralisation (SN) test.

Passive surveillance

Because SVD is notifiable on clinical suspicion for both veterinarians and farmers, cases with suspect clinical signs will be investigated following notification to the Swedish Board of Agriculture. The investigation includes restrictions on the farm during the investigation, sampling of sick or dead animals and examination of the herd for prevalence of clinical signs and analyses of production results.

Active surveillance

At present, active surveillance for SVD is not performed on a regular basis; the most recent active surveillance was performed in 2013.

RESULTS

Passive surveillance

No clinical suspicions of SVD were investigated during 2016.

Active surveillance

No active surveillance for SVD was performed during 2016. See previous reports for surveillance results from 2013 and earlier.

DISCUSSION

The result from the surveillance of SVD in Sweden gives additional documentation of freedom from this infection in the Swedish commercial pig population. During recent years, the Swedish pig industry has undergone substantial structural changes leading to a rapidly declining number of herds and extensive changes in the market and in the habits of farmers. The active surveillance in terms of planning design and number of samples is therefore evaluated for each surveillance occasion and adjusted accordingly if needed. Discussions are ongoing within EU and OIE concerning the status of this disease.

Scrapie



Photo: Ylva Persson

BACKGROUND

Scrapie belongs to a group of diseases called Transmissible Spongiform Encephalopathies (TSE) and was first described more than 250 years ago. The current theory about the causative agent is the protein-only hypothesis. This theory assumes that misfolded prions (small proteins) induce the same misfolded and pathological structure in normal proteins of the host, resulting in accumulation of prions and cellular damage without involvement of any microorganism. Susceptibility to scrapie is genetically related. All routes of transmission have not been established, however, it is clear that transmission of classical scrapie occurs within a flock at lambing and that pastures can be contaminated for long periods of time. Scrapie has based on epidemiological data not been considered a zoonotic disease, but the question was raised again in 2014 after experimental infection studies in transgenic mice.

After classical BSE became a disease of public health concern (see earlier chapter on BSE), and the existence of BSE in small ruminants was suspected,

both surveillance and control of TSE in small ruminants was increased within the European Union in 2002.

Classical scrapie has been detected in Sweden once, in a single flock in 1986. The whole flock was culled and the origin of the disease was never established.

In 1998, an atypical variant of scrapie was detected in Norway (Nor98), and this variant was also detected in Sweden in 2003. Since then, a number of cases have been detected in Sweden. Although atypical scrapie is experimentally transmissible, epidemiological studies on the European level indicate that atypical scrapie probably is a spontaneously occurring disease. When transmitted experimentally, atypical scrapie can cause disease indistinguishable from classical scrapie.

DISEASE

The incubation period is long, up to several years. Clinical signs of classical scrapie are related to the neurological system and include altered behaviour and sensation, affected movement and posture, as

well as pruritus and skin lesions. The disease is progressive and always fatal.

LEGISLATION

Surveillance and control is regulated through the Regulation (EC) 999/2001 of the European Parliament and of the Council of 22 May 2001. At the national level, surveillance and control has also been regulated by Sweden's national scrapie control programme. Since 2003, Sweden has had additional guarantees related to trade within the union, Commission Regulation (EC) 546/2006. In 2016, Sweden was granted the status: "negligible risk" for classical scrapie through Commission regulation (EC) 2016/1396 amending Regulation (EC) 999/2001. This replaces the need for additional guarantees and a national control programme.

Sampling at the national level is regulated by SJVFS 2010:9, last amended through SJVFS 2013:3. Scrapie is a notifiable disease under the Swedish Act of Epizootic diseases (SFS 1999:657, with amendments) and there is a scheme to compensate farmers for losses due to eradication measures.

SURVEILLANCE

The Swedish Board of Agriculture is responsible for the surveillance programme, which is carried out in cooperation with the National Veterinary Institute which is appointed the National Reference Laboratory (Regulation (EC) 999/2001). Samples are analysed at the National Veterinary Institute.

Passive surveillance

All suspicions of scrapie must be reported to the authorities. The obligation to report applies to animal owners, veterinarians and everyone else who is responsible for the animals. Samples from animals with clinical suspicion of scrapie are examined with Bio-Rad TeSeE short assay protocol (SAP) in combination with Bio-Rad TeSeE Western Blot.

Active surveillance

The design of the surveillance programme is in accordance with Regulation (EC) 999/2001 Annex III and was during 2016, until the approval of the negligible risk status also in accordance with the Swedish national control programme. Within the programme, all dead sheep and goats over 18 months of age which are not slaughtered for human consumption have been sampled. The carcasses are sampled at rendering plants and at necropsy. In remote areas where there is no collection of carcasses,

the farmers have been obliged to send the whole head to the National Veterinary Institute for testing. Farms with confirmed cases of atypical scrapie are obliged to have increased surveillance in the herd for two years. In addition to fallen stock, healthy slaughtered animals above 18 months of age are examined from these flocks.

The samples from active surveillance were examined with Bio-Rad TeSeE short assay protocol (SAP) at the National Veterinary Institute in accordance with Regulation (EC) 999/2001. In case of positive or inconclusive results the material was examined by Bio-Rad TeSeE Western Blot.

RESULTS

Passive surveillance

In 2016, no sheep or goats were examined due to clinical suspicion of scrapie.

Active surveillance

Sheep

In 2016 the National Veterinary Institute examined 6,369 sheep from fallen stock for scrapie. Out of these, all samples were negative for classical scrapie and three were positive for atypical scrapie Nor98.

Goats

In 2016, the National Veterinary Institute examined 49 goats from fallen stock for scrapie. All were negative both for classical scrapie and for atypical scrapie.

DISCUSSION

Classical scrapie

Since the start of the active surveillance in 2002, more than 75,000 sheep have been tested without any positive cases detected. In 2014, Sweden sent an application to the European Commission to obtain status as country with negligible risk for classical scrapie. The dossier contained detailed information about the population, imports (which were limited), education about the disease, the national control programme as well as results of estimates of the probability that Sweden is free from classical scrapie. The Commission evaluated the dossier and also asked the European Food Safety Authority (EFSA) for an opinion. The opinion was published in November 2015 (doi:10.2903/j.efsa.2015.4292) and it was concluded that:

Sweden has tested annually a sufficient number of ovine and caprine animals over 18 months of age, sourced from the NSHC and SHC, to provide a 95%

level of confidence of detecting CS if it is present in that population at a prevalence rate exceeding 0.1% which is the requirement set in Regulation 999/2001. In August 2016, the application was approved and Sweden was granted status negligible risk for classical scrapie through Commission regulation (EC) 2016/1396.

Sweden has previously had additional guarantees from the EU related to scrapie when farmers import sheep or goats, and these are now replaced by the rules in Regulation 999/2001 defining rules for trade for countries with negligible risk. However, illegal imports that are not detected could pose a potential threat to the current scrapie status in the Swedish sheep and goat population.

After Sweden has been granted status negligible risk, the surveillance programme will be adapted. A sufficient number of sheep and goats will be sampled annually to retain status negligible risk, but not all fallen sheep above 18 months of age will be sampled.

Atypical scrapie

Since the first case of atypical scrapie was detected in Sweden in 2003, more than 40 cases have been detected up to the end of 2015. Out of these, two were detected through passive surveillance and the rest through active surveillance. Currently, the flocks are put under intensified monitoring in accordance with the regulation (EC) 999/2001. No additional cases of atypical scrapie have been found in

the positive flocks. At the European level, two epidemiological studies have concluded that the prevalence is similar in different countries and that the prevalence in positive flocks does not differ from the prevalence in the rest of the sampled population. This pattern differs from the way contagious disease are normally distributed in the population and support the hypothesis that atypical scrapie is spontaneously occurring. Although within flock transmission between animals seems to be very low (if it exists) other routes of spread and the potential zoonotic aspect are being discussed.

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Tick-borne encephalitis

BACKGROUND

Tick-borne encephalitis virus (TBEV) belongs to the genus flavivirus in the family *Flaviviridae*. TBE virus is endemic in an area ranging from northern China and Japan, through far-eastern Russia to Europe. The virus may cause a neurological infection which may lead to long-term sequelae in the affected patients. The virus is spread by ticks (*Ixodes ricinus* and *I. persulcatus*), which are infected when they suck blood from infected rodents. Rodents are suggested as a possible virus reservoir. The virus also circulates in the tick population through transovarial transmission without involvement of vertebrate hosts. Large mammals, predominantly ungulates, are important to the maintenance of large tick populations. Humans typically become infected via ticks, although unpasteurised cow's and goat's milk and milk products have also been reported as sources. Vaccination of persons living, visiting or working in endemic areas is recommended.

Three sub-types of TBEV are described: the "Western", "Siberian" and "Far eastern" subtypes. In Sweden, only the "Western" subtype has been identified.

The first case of TBE infection in Sweden was reported in 1954. During the following three decades, 10-40 annual cases were reported. From the mid-1980s a clearly increasing trend has been observed. In recent years about 150-300 cases have been reported annually. With a few exceptions, the cases have been domestic. A majority of the cases acquire their infections in Sweden. Most have been infected on the east coast of Sweden and the Stockholm archipelago but in recent decades cases have been observed regularly on the west coast of the country. The age distribution is wide but most of the cases are between 30 and 70 years. There is a slight over-representation of men. A majority of the patients are diagnosed in July to October.

During 2015, a total of 1,176 samples of bulk tank milk from dairy herds were analysed for TBE. The results of this investigation are not yet available.

DISEASE

Animals

A few confirmed cases of disease in dogs have been reported. Seroconversion has been demonstrated in grazing goats and cows. Most authors consider

these animals to be a dead-end hosts for the viral infection. Wild rodents are the natural reservoir for TBEV but are not reported to contract the disease. Roe deer have been shown to seroconvert and they have consequently been suggested as an indicator of the prevalence of the virus. However, there have been no reports of disease in this species.

Humans

In humans, a biphasic course of the disease is common. The first, viraemic phase lasts for about four days. After an interval of about a week, a meningoencephalitic phase appears in about one third of the patients. The symptoms may include fever, headache, nausea, cognitive dysfunctions or spinal paresis. The mortality is low, about 0.5%. The incubation period of TBE is usually between 7 and 14 days.

LEGISLATION

Animals

Demonstration of TBE virus or antibodies in animals is not notifiable.

Humans

TBE in humans is notifiable as a viral meningoencephalitis since 2004 according to the Communicable Disease Act (SFS 2004:168 with the amendments of SFS 2013:634).

SURVEILLANCE

Animals

The surveillance in animals is passive. During 2016, seven dogs and one cat were tested for TBE antibodies.

Humans

The surveillance is passive in humans.

RESULTS

Animals

Two of the dogs were positive, it is however not known if the clinical signs in these dogs were caused by TBEV-infection.

Humans

In 2016, 238 cases of TBE were reported, which is at a similar level to previous years (Figure 19). In

the longer term, since 1983 the TBE incidence has shown a significantly rising trend of 6% each year.

More men (66%) than women were reported with TBE. The incidence was highest among people in the age group 40-59 years, but there were cases reported from the age of 2 months to 87 years of age.

All but four cases had acquired their infections in Sweden. The imported cases had been infected in Finland (three cases) and Lithuania (one case).

The first TBE cases became ill in mid-April and the last in mid-November, but the peak occurred in July.

The geographic distribution of the disease was mainly, as in previous years, concentrated in the coastal areas of Stockholm, Södermanland and Uppsala counties, both along the lake of Mälaren and the Baltic Sea (Figure 20). The incidence was highest in the counties of Uppsala (11.9 cases per 100,000 inhabitants) and Södermanland (5.6 cases per 100,000

inhabitants). However, the infection also occurs in many other parts of the country from the county of Skåne in the south to southern Gävleborg and Dalarna in the north.

DISCUSSION

Although there was a decrease in the number of cases in most Swedish counties in 2016, in the long run the TBE incidence has shown a significantly rising trend during the last three decades.

This increase is probably due to several interacting factors. The most important cause is presumably the very dense population of ticks, a consequence of a large roe deer population from the 1980s up until the recent snowy winters. This situation in combination with a high population of small host animals such as bank voles, and optimal weather for both virus spread and humans spending time outdoors, could explain the large number of cases reported.

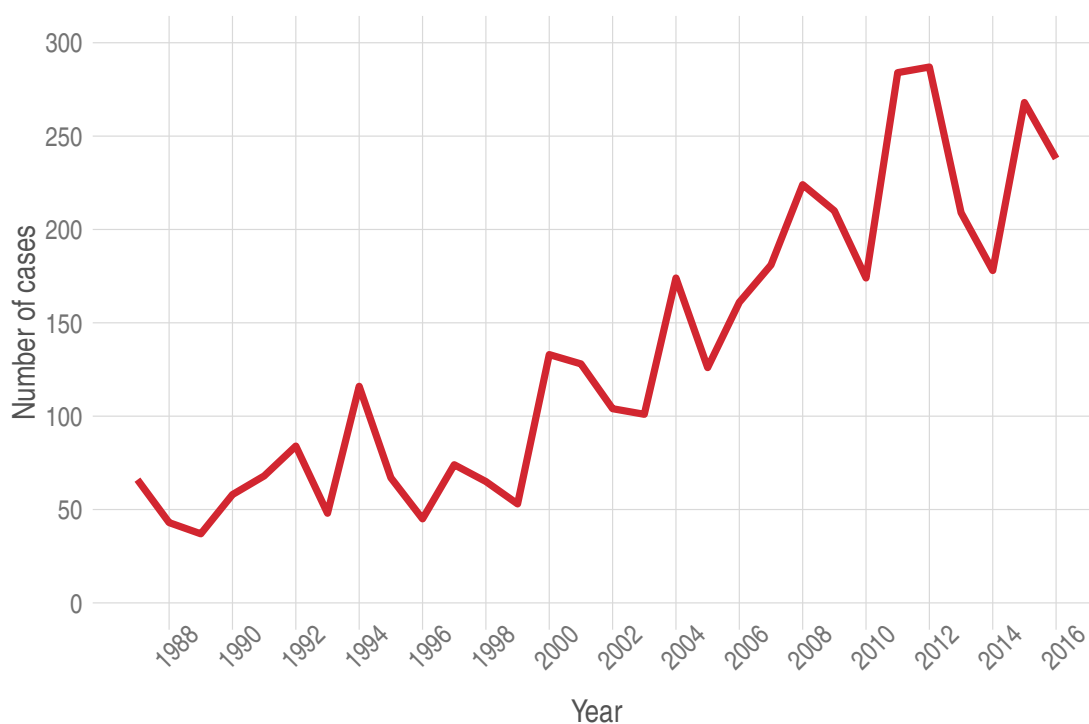


Figure 19: Number of notified cases of TBE in humans 1987-2016.

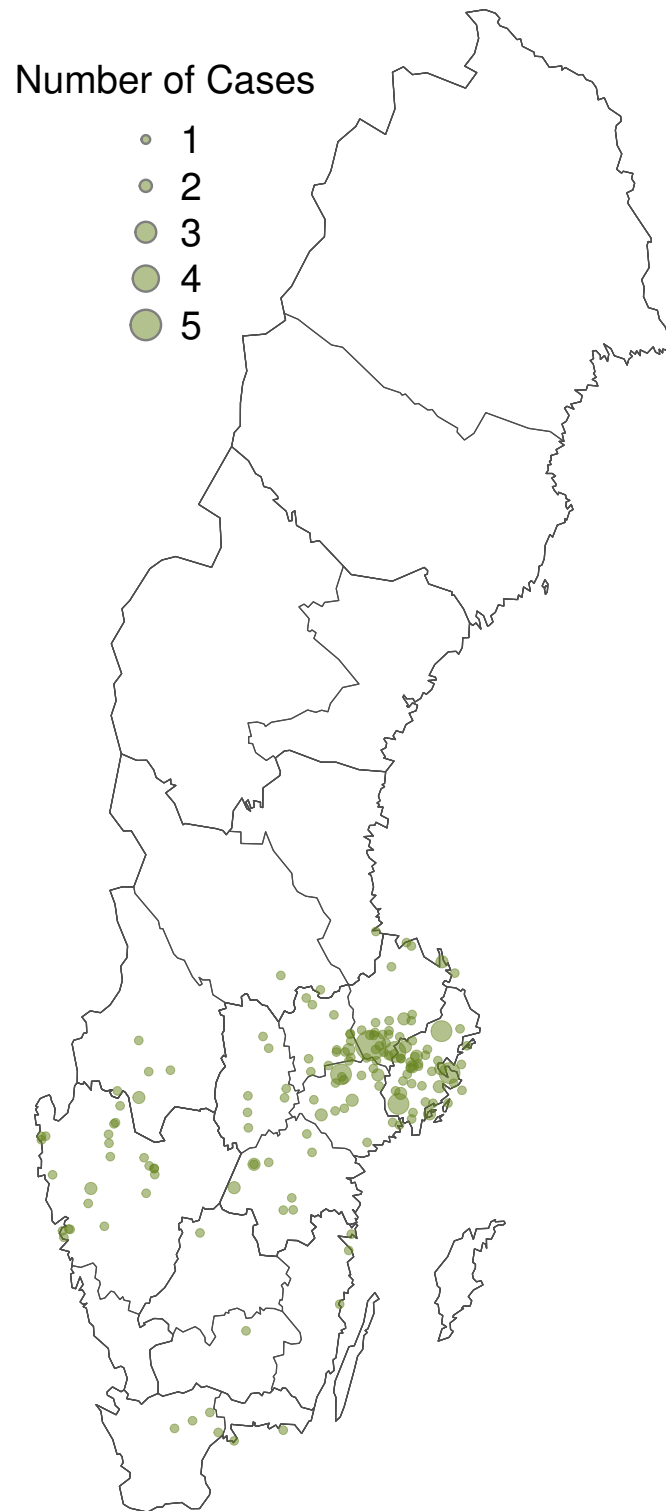


Figure 20: The geographic distribution of the place of infection of cases of TBE in 2016.
©EuroGeographics for the administrative boundaries.

Transmissible gastroenteritis

BACKGROUND

Transmissible gastroenteritis (TGE) is a disease of pigs caused by a coronavirus that can result in severe losses in seronegative herds mainly due to very high piglet mortality caused by severe diarrhoea. The disease is widespread in pig producing areas of the world. In the 1980s a mutant of TGE virus was detected; porcine respiratory corona virus (PRCV). PRCV replicates in the respiratory tract instead of in the intestines and only causes subclinical infection. The mutant spread rapidly and has limited the impact of TGE by giving rise to neutralising antibodies to TGE virus.

TGE is highly contagious and the main means of transmission is through direct contact between pigs and indirectly through fomites and equipment contaminated with manure. There is a seasonality in the epidemiology of the disease with more frequent outbreaks during the winter. This seasonality has been attributed to the high UV- and temperature sensitivity of the TGE virus.

The disease has never been reported in Sweden.

DISEASE

Introduction of TGE virus to a susceptible seronegative herd leads to a rapid spread of the infection with clinical manifestation in all age groups, but piglets are the most severely affected. Clinical signs include vomiting, severe watery diarrhoea and dehydration in piglets under 2 weeks of age. Mortality can approach 100%. Previous infection with PRCV protects against the severe forms of TGEV infection.

LEGISLATION

TGE is a notifiable disease (SJVFS 2013:23) based on detection of the virus or increased antibody levels in paired samples.

SURVEILLANCE

The purpose of the active surveillance programme is to document freedom from TGE in the Swedish pig

population. The National Veterinary Institute is responsible for selection of samples, sample analysis and reporting to the Swedish Board of Agriculture.

The serological analyses for TGE antibodies are performed with an ELISA that can distinguish between antibodies to TGEV and PRCV (Svanovir TGEV/PRCV-Ab).

Passive surveillance

Since TGE has never been reported in Sweden and herds are expected to be seronegative, it is expected that an introduction of the disease would lead to severe clinical signs in the infected herd.

Active surveillance

Active surveillance for TGE is at present not performed on a regular basis and the most recent surveillance was performed in 2013.

RESULTS

Passive surveillance

No clinical cases of TGE were reported during 2016.

Active surveillance

There was no active surveillance for TGE during 2016. See previous reports for surveillance results from 2013 and earlier.

DISCUSSION

The spread of PRCV in Europe has led to a diminished importance of TGE. However, if introduced into a seronegative population of pigs, TGE could be very serious. The effects of introduction of another coronavirus in pigs, porcine epidemic diarrhoea virus (PEDV), into a seronegative population has been demonstrated recently in the USA and Canada where the effects of the introduction has been devastating. It is considered possible to maintain freedom from both TGEV and PEDV in the Swedish pig population as long as the restrictive regime concerning import of live animals is maintained.

Trichinellosis

BACKGROUND

Trichinellosis is caused by parasitic nematodes of the genus *Trichinella*. The parasites can be hosted by different mammals including domestic pigs and horses but the main reservoirs are wild carnivores and omnivores. Humans typically acquire the infection by eating raw or inadequately heated infected meat and meat products, often cold-smoked, fermented sausages. In Western Europe, the wild boar appears to be the main source of human infection.

In Europe, *T. spiralis* and *T. britovi* are the dominant causes of human infections. In Sweden, these species are also detected as well as *T. nativa* and *T. pseudospiralis*. *T. pseudospiralis* is mainly isolated from wild boars. In the gut, *Trichinella* larvae develop into adults and mate. After mating, the female releases larvae which penetrate the intestinal mucosa and travel via the bloodstream to various organs and muscles. In striated muscles the larvae may survive in an encapsulated form for years.

In Sweden, *Trichinella* has been monitored at slaughter in domestic pigs since the 20th century. From 1970-1990 sporadic cases were detected in domestic pigs, but since 1994 there have been no cases. The parasite is endemic in Swedish wildlife.

The disease is extremely rare in Sweden and detected human cases are usually infected abroad. However, during 2013 a domestic case was reported where the clinical symptom indicated infection with *Trichinella*, although the diagnosis could not be laboratory confirmed. During 2014 and 2015 single cases were reported with country of infection being Poland and Eritrea, respectively.

DISEASE

Animals

Animals rarely develop a clinical infection, although both pigs and rodents can exhibit clinical signs.

Humans

The disease in humans can range from subclinical infection to fatal disease. The incubation period varies from 5-15 days. Symptoms initially involve diarrhoea and abdominal pain and later muscle pain, fever, oedema of the upper eyelids and photosensitivity. Intestinal stages of the disease respond well to treatment. Cardiac and neurological complications may occur 3-6 weeks post infection. *Trichinella* is not transmitted between humans.

LEGISLATION

Animals

Trichinella is notifiable in animals according to SJVFS 2013:23.

Humans

Trichinellosis is notifiable according to the Communicable Disease Act (SFS 2004:168 with the amendments of SFS 2013:634).

SURVEILLANCE

Animals

The digestion method is the only method applied in testing for *Trichinella*. Pig production sites that are officially applying controlled housing conditions are obligated to test all carcasses of breeding sows and boars sent for slaughter according to the regulation (EU) No. 2015/1375. Production sites without controlled housing conditions should test all their slaughtered domestic pigs. In conclusion, fattening pigs originating from holdings officially recognised as applying controlled housing conditions are not obligated to test for *Trichinella*.

All slaughtered horses and hunted wild boars and bears are tested for *Trichinella*. In addition, several species of wild animals are tested for *Trichinella*, including: foxes, lynxes, wolves, badgers, birds and wolverines. The testing of *Trichinella* in animals was performed by six laboratories during 2016.

Humans

Surveillance in humans is passive.

RESULTS

Animals

In 2016, all slaughtered horses (2,534) were tested. The number of tested pigs from controlled housing conditions were 26,697 breeding sows, 731 boars and 860,609 fattening pigs. In addition, 436,320 slaughtered pigs (all categories) from uncontrolled housing conditions were tested. *Trichinella* was not detected in domestic pigs or horses.

Trichinella spp. was detected in 3 out of a total of 91,289 (0.003%) wild boar samples and also in 1 of 225 (0.44%) bears, and also in 7 lynx, 1 red fox and 3 wolves, see Table 17. These figures are based on results from six laboratories testing *Trichinella*

DISEASE SURVEILLANCE 2016

and include wild boars (15,670) and bears (79) submitted to wild game establishments as well as samples taken by private hunters.

Humans

During 2016 two cases of trichinellosis were reported. One case had eaten raw meat from bear when visiting Georgia. The other guests were eating the meat cooked and did not become ill. The second case was a person with suspected trichinellosis who had been to Turkey before onset of disease. However there was no information about consumption

of food that could be a risk and country of infection was not established.

DISCUSSION

Trichinellosis is extremely rare in Swedish food-producing animals and the few detected human cases in the last decades were infected abroad. The *Trichinella* situation in Swedish animal population seems to be stable. *Trichinella* occurs in wild carnivores and wild boars but the risk of getting *Trichinella* from domestic pigs and horses is negligible.

Table 17: Findings of *Trichinella* in wild animals 2016

Animal species	No. samples	No. positives	Percentage (%)	<i>T. britovi</i>	<i>T. nativa</i>	<i>T. pseudospiralis</i>
Badgers	13	0	0.00%	-	-	-
Bears	225	1	0.44%	-	1	-
Beaver	15	0	0.00%	-	-	-
Fallow deer	1	0	0.00%	-	-	-
Lynx ^A	103	7	6.80%	1	7	-
Lion	1	0	0.00%	-	-	-
Marten	1	0	0.00%	-	-	-
Moose	3	0	0.00%	-	-	-
Otter	20	0	0.00%	-	-	-
Red foxes	55	1	1.82%	1	-	-
Red panda	1	0	0.00%	-	-	-
Seal	10	0	0.00%	-	-	-
Wild birds	33	0	0.00%	-	-	-
Wild boars	91,289	3	0.003%	2	-	1
Wolverine	1	0	0.00%	-	-	-
Wolves ^A	43	3	6.98%	1	3	-
Total		15		5	11	1

^A Two species, *T. britovi* and *T. nativa* were detected in one sample

Tuberculosis

BACKGROUND

Tuberculosis (TB) is a serious disease in humans and animals caused by bacteria included in the *Mycobacterium tuberculosis* complex. *Mycobacterium bovis* causes bovine tuberculosis in several animal species as well as in humans. Historically, the reservoir has been cattle but many other wild and domestic species can also maintain the infection. Wildlife reservoirs including badgers, deer and wild boar cause persistent problems in some countries. Humans usually acquire *M. bovis* infection via unpasteurised milk or via inhalation. The predominant cause of human tuberculosis is however *Mycobacterium tuberculosis*. In countries where human tuberculosis caused by *M. tuberculosis* is common, this bacterium is also frequently isolated from various species of animals.

Sweden was declared officially free from bovine tuberculosis in 1958. Since then, sporadic cases have occurred in cattle, the most recent in 1978. Compulsory tuberculin testing of all cattle was abolished in 1970 and the national tuberculosis control in cattle is now based on meat inspection and passive clinical surveillance.

When Sweden joined the European Union in 1995, the status of OTF (officially tuberculosis free) was obtained.

In 1987, *M. bovis* infection was introduced into the farmed deer population. A control programme for tuberculosis in farmed deer was introduced in 1994 and made compulsory in 2003. The last case of tuberculosis in farmed deer was identified in 1997.

The yearly incidence among humans in Sweden in the early 1940's was above 300/100,000 inhabitants. This was followed by a rapid decline, beginning before effective treatment was available in the early 1950's. Currently, the yearly incidence is 7.3/100,000 inhabitants, which is among the lowest in the world. Around 90% of the cases are born outside of Sweden and the vast majority of them are immigrants originating from countries that still have a high incidence of tuberculosis. The yearly incidence among people born in Sweden is 1/100,000 inhabitants.

DISEASE

The symptoms caused by tuberculosis in both humans and animals depend largely on the localisation of the infection. The disease progresses slowly and clinical signs may take a long time to develop, even in cases with substantial lesions. Weight loss and sometimes coughing (in cases with respiratory tract infection), ascites (due to infection in intestinal lymph nodes or liver) or mastitis (mainly in cattle with udder infection) can be seen. The incubation period varies from weeks to years.

LEGISLATION

Animals

Suspect and confirmed cases of infection with *Mycobacterium bovis*, *M. tuberculosis*, or other mycobacteria in the *M. tuberculosis*-complex, are notifiable in all animal species according to the Swedish Act of Epizootic diseases (SFS 1999:657, with amendments).

Humans

Tuberculosis in humans is a notifiable disease according to the Communicable Disease Act (SFS 2004:168 with the amendments of SFS 2013:634). Contact tracing is compulsory and the treatment is free of charge. Refusing treatment as a patient when being contagious can lead to detention.

SURVEILLANCE

Animals

From suspect animal cases, lymph nodes from five different areas (retropharyngeal, submandibular, mediastinal, mesenteric and inguinal) and organs with macroscopic lesions are collected. Histology and direct smears are performed on all materials. If TB cannot be ruled out by histology or if direct smears are positive, culture is performed. Cultures are performed on solid media (Löwenstein-Jensen and Stonebrink's) according to the method at the National Veterinary Institute and cultured for up to twelve weeks. Suspected colonies are tested with PCR and if necessary with sequencing of a specific gene. Isolates suspected to belong to the *M. tuberculosis*-complex or where the *M. tuberculosis*-complex cannot be ruled out are sent for confirmation to the Norwegian Veterinary Institute or the Public Health Agency of Sweden. Positive isolates

are further subtyped.

Skin fold tuberculin tests are performed according to EC 1226/2002 (amending annex B of EC 64/432) and SJVFS 2003:33, K62. The comparative intradermal test is used, mostly at the neck site. In case of a positive tuberculin test, the animal is culled and sampled as stated above. Culture is performed on all samples.

Since 2012, testing of alpacas for tuberculosis has been done using a serological test instead of an intradermal test as the intradermal test has a demonstrated low sensitivity in alpacas.

Humans

In humans sputum smear and culture is the standard test when pulmonary tuberculosis is suspected. Otherwise culture from urine, faeces, blood or liquor is also a possibility, or biopsies from suspected site of infection.

Passive surveillance

Animals

As TB is notifiable on clinical suspicion, clinical signs in animals or lesions detected at necropsy of an animal, prompt official investigations including sampling for bacteriology, tuberculin testing of contact animals and epidemiological investigations are carried out.

In addition, an investigation is performed if there is a reason to suspect exposure of animals to bacteria of the *M. tuberculosis*-complex.

Humans

The surveillance in humans is mainly passive but contact tracing around diagnosed cases is compulsory and asylum seekers from high incidence countries are offered health examination where screening for TB is included.

Active surveillance

Animals

Monitoring is performed by meat inspections at slaughter of food producing animals. Veterinary officers of the National Food Agency perform the inspections. Suspect lesions are sent to the National Veterinary Institute for histology and bacteriology.

The control programme in farmed deer was, until October 2012, based on regular whole-herd tuberculin testing, or whole-herd slaughter and meat inspection. Since October 2012, tuberculin tests are no longer performed in TB-free herds, but inspections at slaughter and necropsy of animals found

dead or euthanized are still required.

A voluntary control programme in alpacas was launched by Farm and Animal Health in 2015. All grown up animals in the herd are serologically tested and all animal purchases and contacts with other herds are recorded.

Furthermore, tuberculin tests are performed at artificial insemination centres and at export of animals as required according to EU-legislation (Council Directive 64/432/EEC).

RESULTS

Animals

Due to lesions detected at slaughter, 24 pigs, four cattle and one sheep were investigated by histology and, if relevant, by culture. From these samples NTM (Nontuberculous mycobacteria), from the *Mycobacterium avium/intracellulare*-complex were isolated in 17 pigs. No other samples yielded any mycobacteria. Due to clinical suspicions or lesions found at necropsy, samples from two deer, one alpaca, one dog and two cats were investigated. From these samples NTM, from the *Mycobacterium avium/intracellulare*-complex were isolated in one dog and one cat. No other samples yielded any mycobacteria. Due to a positive tuberculin test, one bull was euthanized, necropsied and cultures from relevant organs were performed, all with negative results. An epidemiological investigation was performed and all other animals in the herd that had been in contact with the bull were tuberculin tested with negative result.

In 2016, the number of holdings of farmed deer that were considered active, kept deer and had obtained TB free status, was 279. Eight herds were not tested. These herds are exempt from regular testing and instead, they slaughter of 20% of the herd yearly with meat inspections and necropsies for 15 years to obtain a free status. No TB was detected in any farmed deer in Sweden during 2016.

During 2016, 20 alpacas were tested before export or import and 11 alpacas were tested serologically as part of a health control, all with negative final results. Within the voluntary control programme 329 alpacas were tested, all with negative final results.

Humans

Five cases of *M. bovis* were reported in humans in 2016; three cases of peripheral lymphadenitis, one with gastrointestinal disease and one with pulmonary involvement. The cases with lymphadenitis

were all young men from Syria and Afghanistan, the gastrointestinal disease an elderly woman of Somali origin and the pulmonary case a middle-aged man from Mali. None of them were classified as having been infected in Sweden.

DISCUSSION

Animals

The officially free status for bovine tuberculosis has been maintained during 2016. The overall TB situation in animals and humans remains favourable. No cases of TB were detected in Swedish animals during 2016. Although the surveillance is mainly dependent on inspections of slaughtered animals, this is considered sufficient for monitoring. However, the submission rates of lesions from slaughtered ruminants should be improved. Passive surveillance based on clinical suspicions and necropsy findings will always have a low sensitivity as clinical symptoms and massive lesions are mainly seen in late stages of the infection.

The eradication efforts in farmed deer have been successful and the probability that Swedish farmed deer are TB free is high. The aim is to be able to declare the remaining deer herds officially free.

Humans

The rapid decline of tuberculosis in humans in the 1940's coincided with the eradication of tuberculosis in cattle and started before the introduction of effective treatment in the 1950's. A much larger part

of the human population lived in close contact with domestic animals. This change in contact between humans and animals possibly played a role in the changing TB incidence in humans. Today, Sweden has one of the lowest incidences of human tuberculosis in the world.

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Tularaemia



Photo: Karin Bernodt

BACKGROUND

The bacterium *Francisella tularensis* is the causative agent of tularaemia, a disease affecting many animal species, including humans. There are several subtypes of *F. tularensis* of variable virulence. *F. tularensis* subsp. *holarctica* (type B) is the main subspecies responsible for human and animal infection in Europe.

F. tularensis is capable of surviving for weeks at low temperatures in water, moist soil, or decaying plant and animal matter. Although many different animal species can be infected, tularaemia is typically found in hares and small rodents.

Humans become infected through a variety of mechanisms such as handling infected or dead animals, bites of infected insects or other arthropods, ingesting contaminated food or water, and inhaling aerosols of bacteria. Clinical disease is variable and dependent on the route of transmission. The infection is more often reported in men than in women,

which might be attributed to their leisure and professional activities. The age group of 45-70 years is the most affected in both sexes. Tularaemia may occur during the whole year, but it is most frequent during late summer and early autumn.

Sweden has reported cases of tularaemia since 1931. Ever since the first Swedish tularaemia case was reported, endemic areas have been identified in northern and central Sweden.

The mountain hare is the animal species in which tularaemia has most frequently been identified in the endemic areas. However, during the last decade tularaemia has also commonly been diagnosed in the European brown hare, and in regions south of the endemic areas.

The annual numbers of reported human cases range from a few cases to more than 2,700 cases in 1967.

DISEASE

F. tularensis is highly infectious, as few as 10-50 colony forming units may cause infection. The incubation period is usually 3-5 days. Tularaemia can be manifested in different forms depending on the route of transmission and on the virulence of the organism. These forms are: ulceroglandular, oculoglandular, pneumonic, oropharyngeal, gastrointestinal and typhoidal.

Animals

In Swedish hares, and in many rodent species that die of tularaemia, the pathological presentation of the disease is a disseminated multi-organ septicaemic form.

Humans

The ulceroglandular form is the most common form; the respiratory, oculoglandular and oropharyngeal forms being less common. In the ulceroglandular form, a local ulcer usually appears at the site of infection and the adjacent lymph nodes are enlarged. The general symptoms of tularaemia are high fever, headache and nausea.

LEGISLATION

Animals

Tularaemia is notifiable in animals (SJVFS 2013:23).

Humans

Tularaemia has been a notifiable disease since 1970 according to the Communicable Disease Act (SFS 2004:168) with the amendments of SFS 2013:634.

SURVEILLANCE

Animals

Surveillance in animals is passive. Surveillance is based on voluntary submission of animals found dead or euthanised by hunters and the general public. Detection is based on PCR or immunohistochemistry of the animal sample.

Humans

The surveillance is passive. For laboratory verification of the infection serology, PCR and isolation of the bacteria could be used.

RESULTS

Animals

In 2016, 36 European brown hares, three mountain hares, and two hares for which the hare species

could not be determined, were examined. *F. tularensis* sp *holarctica* was detected in six European brown hares and none of the mountain hares. The six hares had all died of an acute disease spread to several organs, and finally ending with sepsis. Five originated from central parts of Sweden (Uppsala, Södermanland and Dalarna), and one from Västra Götaland in the southwest part of the country. The number of cases in 2016 is approximately at the same level as other years without outbreaks, for example eleven cases in 2013 and two in 2014. This could be compared to the outbreak year 2015 when tularaemia was diagnosed in 31 hares, the majority coming from the outbreak area.

Humans

In 2016, 134 human cases of tularaemia were reported, which is a sharp reduction in comparison to the previous year (Figure 21). The decrease in the number of cases could probably be explained by the fact that the unusually intense circulation of tularaemia both among humans and animals in 2015 had come to an end. As a rule, there are large natural fluctuations in the number of tularaemia cases observed between years and in different regions. This is probably due to several factors like the number of reservoirs and mosquitoes, as well as weather conditions. Even though the tularaemia incidence has varied a lot between years, since the beginning of the 1990s it is at a significantly higher level.

More men (61%) than women were reported to be infected in 2016, which is in accordance with previous years. The incidence of tularaemia was highest in the age group 40-69 years, which is also similar to previous years. The uneven distribution among age groups and sexes might partially be attributed to their somewhat different leisure and professional activities.

As in previous years, except for a few sporadic cases, tularaemia was only reported from the northern, western and central parts of Sweden. During 2016, the incidence was highest in the county of Örebro with 11,5 cases per 100,000 inhabitants. In the counties of Norrbotten and Västerbotten, where the majority of people acquired their infections in 2015, there was a sharp reduction in the number of cases. In 2016, six cases were reported as imported, all of them from Finland and Norway.

About three quarters of the cases for whom a route of transmission had been specified, were reported to have been infected via an insect bite but the true number is likely to be larger, since the route

of transmission is not always specified in the notification. There are estimates that about 90% of the Swedish tularaemia cases are caused by mosquito bites. In 2016, 15 cases were assumed to have been infected through direct contact with animals, three persons had according to the notifications been infected through their work and two by drinking water.

During the first half of the year, just a few cases were reported each month. The number of cases started to increase in July and peaked in August. During the autumn the number of cases subsided.

DISCUSSION

Tularaemia has been endemic in northern and central Sweden at least since the early 20th century with a marked annual variation. Years with high numbers

of cases are often followed by periods when the disease is virtually absent. There is no obvious explanation for these fluctuations. The reservoir for the bacterium between outbreaks has not been clearly identified. During the last decade, the epidemiology of tularaemia has changed and the number of reported cases in humans and animals, mainly European brown hares, infected south of the previous endemic region has increased. In animals, outbreaks of tularaemia have in some countries been associated with rises in rodent and hare populations, but this has not been confirmed in Sweden. It is possible that the European brown hare has become an important carrier of *F. tularensis* in many areas, but its epidemiological role remains unclear.

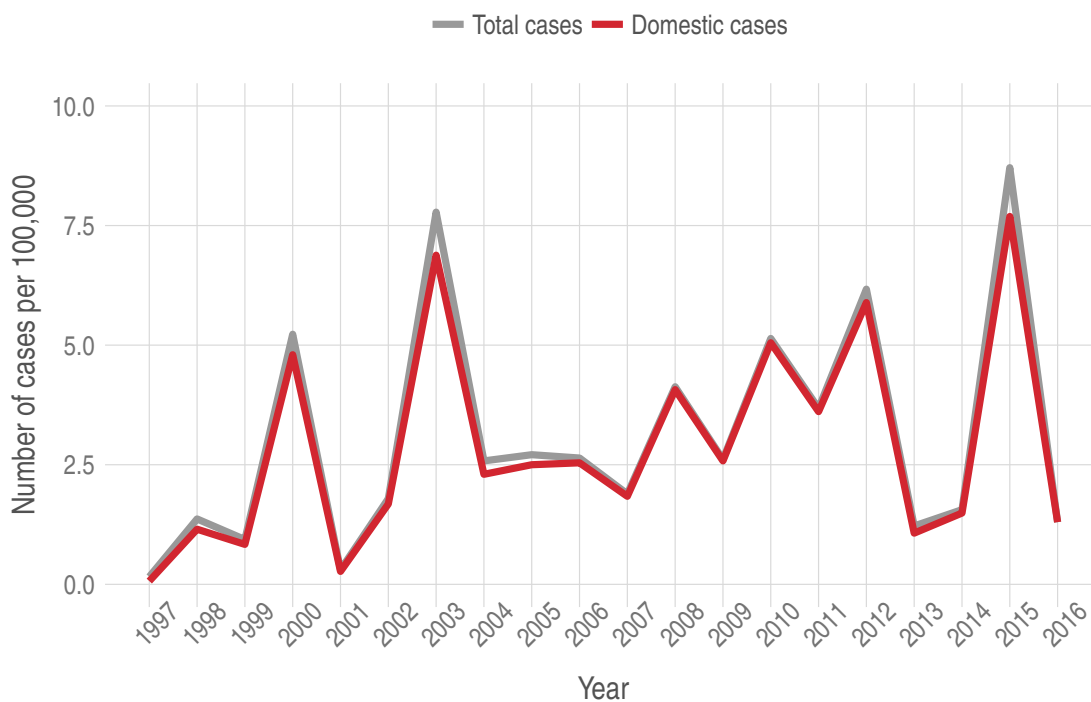


Figure 21: Incidence of notified human cases of tularaemia in Sweden 1997-2016

Verotoxinogenic *Escherichia coli*

BACKGROUND

Verotoxinogenic *Escherichia coli* (VTEC) may cause serious intestinal infections in humans. When these bacteria cause hemorrhagic diarrhoea they are called EHEC (enterohaemorrhagic *E. coli*). More than 380 different VTEC serotypes have been associated with human illness. Shiga toxin-producing *Escherichia coli* (STEC) is used synonymously with VTEC. The toxin can be divided into two main groups, shigatoxin 1 (stx1) and shigatoxin 2 (stx2), and then further divided into several subtypes, for example, stx1a. Previously, many outbreaks and severe disease were caused by serotype O157:H7, but in recent years other serogroups have emerged. Often the strains associated with severe disease carry the stx2 gene. Other common serotypes causing gastrointestinal illness are O26, O103, O111, O121 and O145. Cattle are the main reservoir of VTEC associated with human disease although other animal species also may carry the organisms. The infectious dose is low, probably less than 100 bacteria. Not only foods of bovine origin but also vegetable food items and drinking water have been implicated in outbreaks. The infection can also be transmitted through direct or indirect animal contact, via environment or person-to-person contacts.

VTEC was only sporadically detected in Sweden before 1995, when 114 human cases of EHEC O157:H7 were notified. In 1996, VTEC O157 was isolated in Swedish cattle for the first time and human EHEC O157 infection was traced to a cattle herd. In 2002, an outbreak of EHEC O157:H7 in the county of Skåne affecting 30 persons was caused by consumption of cold smoked fermented sausage. The largest Swedish outbreak so far occurred in the summer of 2005 when 135 reported cases, including 11 (8%) HUS (haemolytic uraemic syndrome) cases, were infected with O157:H7 after eating contaminated fresh lettuce. The lettuce had been irrigated with water from a local stream positive for verocytotoxin 2 at the time of harvest. Indistinguishable isolates from humans and cattle faeces from a farm upstream confirmed the implicated source, and control measures that lead to the termination of the outbreak were implemented.

Between 250-550 cases (3-6 cases per 100,000 inhabitants) of EHEC infections have been reported

in Sweden annually, of which 50%-60% are domestically acquired. Most of the domestic cases are reported during the period July to September.

DISEASE

Animals

Animals usually do not develop clinical disease.

Humans

The clinical picture may vary from asymptomatic infection to non-haemorrhagic or haemorrhagic diarrhoea associated with abdominal cramps. Most patients fully recover. Approximately 7-10% develop HUS, which is characterised by acute renal failure, thrombocytopenia, and microangiopathic haemolytic anaemia and the condition may lead to death. A large proportion of the patients are young children and severe complications are most common in this age group as well as, among elderly people.

LEGISLATION

Animals

Since 1999, VTEC O157 findings in animals are notifiable when associated with human VTEC infection (SJVFS 2013:23).

Humans

EHEC O157 has been notifiable for both clinicians and laboratories under the Swedish Communicable Disease Act since 1996. All EHEC serotypes pathogenic to humans have been notifiable since 1 July 2004 (SFS 2004:168 with the addition of SFS 2013:634). A laboratory confirmed case could also include those cases that are only positive by PCR i.e. where no isolate could be obtained.

SURVEILLANCE

Animals

Surveillance of VTEC in animals is active and consists of traceback investigations from human EHEC cases and prevalence studies of VTEC in abattoirs.

Traceback from human cases

If a County Medical Officer suspects an association between a human EHEC infection and animals, or a farm with animals the County Veterinary Officer will be informed. A request will be made to the

Swedish Board of Agriculture for a trace back investigation and sampling of suspected animals, and/or the environment of the animals.

Abattoir surveys

Between 1997 and 2002, annual prevalence studies of VTEC in cattle at abattoirs were conducted. Since 2002, prevalence studies have been performed every third year. In the studies conducted during 2011-2012 and 2014-2015, all positive VTEC O157:H7 were also analysed for a variant of VTEC O157:H7, called clade 8. This variant is often isolated from cattle farms associated with human cases. A baseline study on cattle carcasses was done in 2006-2007 and a prevalence study in sheep was done at nine abattoirs in 2007-2008. Results from a slaughter prevalence study from 1998 showed that 0.1% of the pigs were positive for VTEC O157:H7.

Humans

Surveillance in humans is passive. Isolates from human cases are sent to the Public Health Agency of Sweden for typing.

RESULTS

Animals

Traceback from human cases

During 2016, one goat farm, one farm with both goat and cattle, five sheep- and seven cattle farms were investigated as suspected sources for human infection. An epidemiological association was established for one sheep and four cattle farms with VTEC O157:H7.

Abattoir surveys

VTEC O157 was detected in nine (1.8%) of 492 faecal and 2 (1.9%) of 105 ear samples from sheep in a survey performed in 2007-2008. In cattle, surveys during 1997-2002 showed a prevalence of approximately 1%. In the study done in 2005-2006, VTEC O157 was detected in 3.4% of faecal samples. In the abattoir survey conducted in 2008-2009 VTEC O157 was detected in 3.3% of 1993 faecal and 8.2% of 500 ear samples in cattle. In the study conducted during 2011-2012, VTEC O157 was detected in 73 of 2,376 faecal samples (3.1%) from cattle. Clade 8 was detected in 15 of the 73 positive samples. In the study conducted during 2014-2015, VTEC O157 was detected in 33 of 1,492 faecal samples (2.2%) from cattle. Clade 8 was detected in 5 of the 33 positive samples. In these studies, VTEC O157:H7 has predominantly been isolated from cattle in southern

Sweden but rarely from the northern two thirds of the country. The collected samples during 2011-2012 were also analysed for VTEC O26 and VTEC O103. VTEC O26 was detected in 8 of 1,308 faecal samples (0.6%) and in 15 of 336 cattle ear samples (4.5%). VTEC O103 was detected in three of 1,000 faecal samples (0.3%) and in three of 500 ear samples (0.6%).

Food

Available results from official sampling by local authorities showed that analysis for *E. coli* O157 was done for 15 samples. Out of these, 8 were taken as a part of a project and 3 samples were taken as part of the investigation of food poisoning/complaints. All 15 samples were negative. There were also 78 samples analysed with gene detection methods. Out of these, 39 were taken as a part of a project and 10 samples were taken as part of the investigation of food poisoning/complaints. Two of these seventy-eight samples were positive. At the border inspection post 2 of 15 samples were positive for genes associated with virulence. However, isolation of living strains with virulence genes was not successful.

Humans

In 2016, 637 human cases were reported, corresponding to an overall incidence of 6.4 cases per 100,000 inhabitants. 73 percent of the cases (465 cases) were domestic, which is the highest number of domestic cases ever reported. The domestic incidence 2016 was 4.7 cases per 100,000 inhabitants and the increasing trend in domestic incidence continued in 2016 (Figure 22). As in previous years, most domestic cases (24%) were in the age group of 1-4 years.

EHEC normally has a seasonal variation with most cases reported during the summer months. In 2016, 34% of the domestic cases were reported from June to September. However, unusual high numbers of cases with EHEC were reported during the spring of 2016, which was due to two outbreaks (described below).

The domestic incidence was highest in the county of Halland (21.2 cases per 100,000 inhabitants) followed by Jönköping (12.8) and Östergötland (11.5). The counties in the southern part of Sweden usually have higher incidences which may partly be due to higher screening frequencies for EHEC of faecal samples from children with diarrhoea.

Of the total number of human cases, 27% were

infected abroad and Turkey was the most common country of infection (20 cases) followed by Spain (10), Thailand (8) and Morocco (8). Turkey and Egypt are usually the countries outside Sweden where most Swedes become infected with EHEC, but the numbers of infected cases from these countries have declined dramatically in 2016 compared to previous years. This is probably a reflection of changed travel patterns.

A total of 19 cases of EHEC-associated HUS were reported; all but 3 were domestically acquired infections. Twelve of the HUS cases were children under the age of 10.

For 13 of the HUS cases an isolate could be retrieved and thereby serotyped (Table 18). Four of the domestic HUS cases belonged to serotype O157:H7, clade 8 which is associated with more severe disease. Also three of the non-serotyped HUS cases could be epidemiologically linked to outbreaks with this serotype.

In 67% of the domestic EHEC cases, an isolate could be retrieved and thereby serotyped. The most common serotypes were O26:H11, O103:H2 and O157:H7.

During the autumn of 2015, a cluster of cases with the same serotype was identified. During the investigation, an additional cluster was discovered but with a different serotype. These two outbreaks continued on in the winter and spring of 2016 and despite large scale investigations no sources of infection could be found. The first cluster belonged to the serotype O26:H11 carrying the *stx1a* and the *eae* genes. A total of 57 cases from 11 different counties were reported; 21 cases in 2015 and 36 in 2016. The second outbreak belonged to the serotype O103:H2 also carrying the *stx1a* and *eae* gene and a total of 76 cases from 11 different counties were reported; 20 cases in 2015 and 56 in 2016. In these two outbreaks no HUS cases were reported and the symptoms were mostly mild.

Some outbreaks were associated with farms or recreational activities near farms. During July to September 2016, eight cases with O157:H7 (*stx2a*, *stx2c*, *eae*) were identified with the same EHEC type. The cases were reported from the counties of Skåne and Blekinge and three of the cases developed HUS and were hospitalized. The investigation lead to sampling of four farms and bacteria with the same type as in humans could be found at three of them.

In September 2016 there were reports of five cases of EHEC (only positive in PCR) that all had

eaten minced beef meat skewers. More cases clustered and in all, 20 cases with the same type of EHEC O157:H7 (*stx2a*, *stx2c*, *eae*) were reported. Four cases developed HUS. Trace back of the skewers lead to one slaughterhouse and to sampling of three farms, of which one was found to have the same EHEC type as the human isolates. However, the outbreak investigation, including surveys and receipt collection, showed that it was only the initial cases that had consumed the skewers, but all others had consumed minced beef meat before turning ill. The slaughterhouse started preventive measures in the autumn of 2016. The preventive measures included slaughter of animals from the specific farm at the end of the day. The outbreak continued in 2017.

DISCUSSION

The incidence of EHEC in 2016 was the highest seen since EHEC became notifiable in 1996 and the overall increasing trend since 2005 continued. Increased sampling of patients due to an increasing awareness is probably one of the most important factors explaining this trend in recent years. In addition, an increasing trend amongst local clinical microbiological laboratories is the use of multiplexed molecular assays (PCR) where a variety of gastro intestinal pathogens are included. Two laboratories in Sweden were using this technique in 2016, meaning that all faecal samples analysed for gastroenteritis also includes analysis for EHEC.

Regionally, there are and have been large differences regarding when and how a fecal sample is tested for EHEC in Sweden. For example, in some regions only children up to 10 are routinely screened, or only when bloody diarrhea is present etc. It is thereby important to follow these changing screening and analysis procedures to understand fluctuations of data over time since this could increase the number of EHEC cases in Sweden if more samples are analysed for EHEC.

Several investigations were performed on suspected connections to farms and food items. Most reported cases from humans are in counties with high cattle-density, for example in the southern parts of Sweden. The highest screening frequency of EHEC in faecal samples of children with diarrhoea has, in a previous investigation, been shown to also be the highest in the southern parts. The higher numbers of cases infected abroad, which can also be found in these parts of Sweden, could partly be explained by these differences in screening routines.

The cause of this has not been fully investigated.

The prevalence among cattle, based on samples taken at slaughter, has since 2005 been in the range of 2.2-3.4%. In these studies, VTEC O157:H7 has predominantly been isolated from cattle in southern Sweden and rarely from the northern two thirds of the country. In the latest survey, positive VTEC O157 samples were also analysed for the subgroup clade 8. There is a tendency for geographical clustering of clade 8.

A joint study between the National Veterinary Institute and the Public Health Agency of Sweden, was initiated in 2012, with the aim to better understand the epidemiology and the underlying mechanisms of different sources of infection and the importance of different serotypes.

Management of zoonotic agents requires collaboration between several authorities within the veterinary and public health sector. A national strategy document containing a plan to reduce the risk of domestic EHEC cases was published in 2014 by the Swedish Board of Agriculture, the National Food Agency, the Public Health Agency of Sweden, the National Board of Health and Welfare and the National Veterinary Institute. The document is based on a synthesis of current knowledge and identifies what actions the authorities consider as important that should be prioritised in order to reduce the risk of domestic infection with VTEC in humans.

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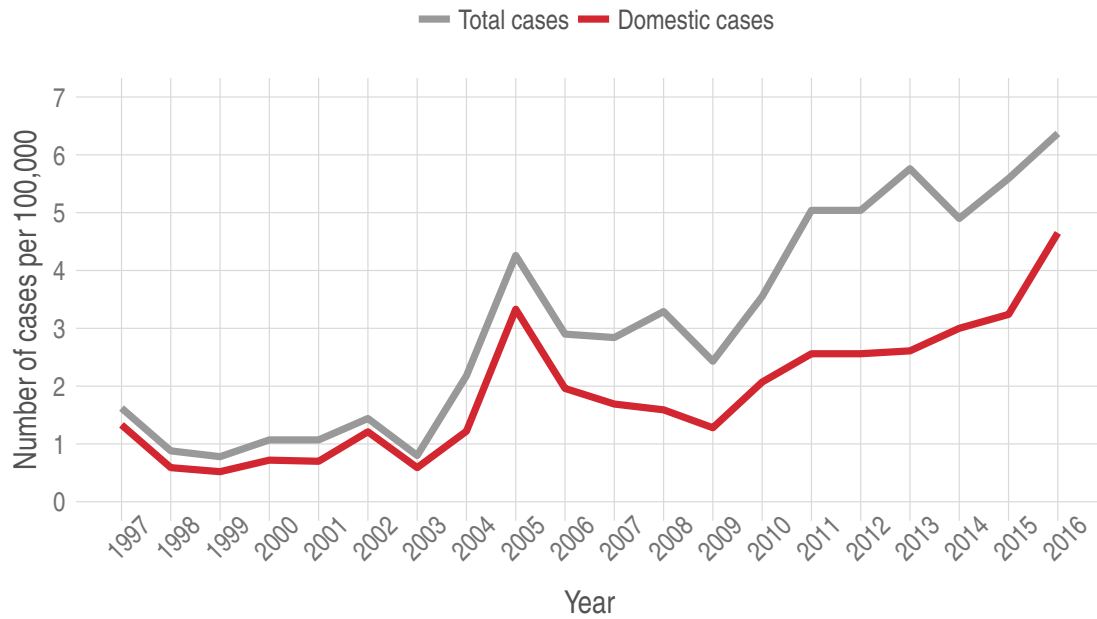


Figure 22: Notified incidence per 100,000 inhabitants of human EHEC cases in Sweden, 1997-2016

Table 18: Distribution of serotypes and shigatoxin-subtypes in HUS (haemolytic uraemic syndrome) cases in 2016.

Serotype	Subtype of Shigatoxin				
	stx1a	stx1c+stx2b	stx2a	stx2a+stx2c	stx2b
O113:H4		1			
O121:H19			2		
O145:H28			1		
O157:H7			1	4	
O182:H25	1				
O21:H21					1
O26:H11	1 ^A		1		
Total	2	1	5	4	1

^A Faeces initially PCR positive for stx2.

Yersiniosis

BACKGROUND

The genus *Yersinia* has been associated with human and animal diseases for centuries. Two enteropathogenic species of the genus are zoonotic: *Yersinia enterocolitica* and *Yersinia pseudotuberculosis*. Pigs are considered the main reservoir of *Y. enterocolitica*. *Yersinia* bacteria are widespread in nature, among which nonpathogenic strains are most frequent. The most common human pathogenic bioserotype is *Y. enterocolitica* 4/O:3.

Wild animals, especially rodents and birds are considered the principal reservoir of *Y. pseudotuberculosis*. Both *Y. enterocolitica* and *Y. pseudotuberculosis* are frequently found in pig tonsils and porcine intestinal contents. Infections caused by *Y. enterocolitica* are thought to be foodborne and pigs are considered the main source of infection. The sources and vehicles of *Y. pseudotuberculosis* infections in humans remain unclear but infections caused by consumption of contaminated carrots and iceberg lettuce have been described in Finland. *Yersinia* bacteria are killed by heating (pasteurisation and cooking); however they are able to grow at refrigerator temperature and can therefore grow in food that is kept cool. In addition, they can grow in vacuum and modified atmosphere packages.

Y. pseudotuberculosis was isolated from diseased guinea pigs in the 1880s. Mainly sporadic cases of yersiniosis were reported in humans until a large outbreak of *Y. enterocolitica* associated with chocolate milk occurred in the USA in 1976. The first food and waterborne outbreaks of *Y. pseudotuberculosis* were reported in 1980s.

During 2014-2015, a survey of the presence of *Y. enterocolitica* on Swedish finishing pig farms was completed. A herd level prevalence of 30.5% was found from 105 farms, and the identified bioserotypes were *ail*-gene positive 4/O:3 and 2/O:9, which are considered to be human pathogens. These results indicate that the Swedish domestic pig population has a similar *Y. enterocolitica* status to other pig producing countries in Europe.

DISEASE

Animals

Pigs are asymptomatic intestinal carriers of pathogenic *Y. enterocolitica* and *Y. pseudotuberculosis*. Infection with *Y. pseudotuberculosis* in other

animals may vary from asymptomatic to severe mesenteric lymphadenitis and lead to septicaemia and death. *Y. enterocolitica* has occasionally been isolated from cats and dogs with diarrhoea.

Humans

Y. enterocolitica causes gastrointestinal symptoms in humans ranging from mild self-limiting diarrhoea to acute mesenteric lymphadenitis, which might be difficult to differentiate from appendicitis. Longterm sequelae including reactive arthritis, uveitis and glomerulonephritis occasionally occur. Prolonged carriage has been reported in children as well as in adults.

LEGISLATION

Animals

Y. enterocolitica and *Y. pseudotuberculosis* are not notifiable in animals.

Food

Y. enterocolitica and *Y. pseudotuberculosis* are not notifiable in food.

Humans

Yersiniosis is notifiable according to the Communicable Disease Act (SFS 2004:168 with the amendments of SFS 2013:634).

SURVEILLANCE

Animals

During 2016, a longitudinal investigation of 8 finisher herds and their source nursery and sow farms was completed. These herds were selected from those that were previously identified as positive for *Y. enterocolitica* in the 2014-2015 study.

Food

There is no active surveillance in food.

Humans

The surveillance in humans is passive.

RESULTS

Animals

In the 2016 longitudinal study of 8 previously positive pig herds, all herds were identified as positive again for *Y. enterocolitica* in at least one of the

samples collected. Analysis is ongoing to compare findings by season and animal production category within the investigated herds.

Food

In 2016, no sample taken in official food control, was analysed for presence of pathogenic *Y. enterocolitica*.

Humans

Yersiniosis is mainly a domestic infection. Of the 229 cases reported in 2016, 74% (n=170) were domestic. Of the 49 imported cases, 24 % (n=12) were infected in Spain. From other countries only a few cases each were reported.

During the years 2000-2004, the number of domestic cases of yersiniosis increased until 2004 when 594 domestic cases were reported (Figure 23). Since 2004, the total number of cases has decreased.

Approximately two-thirds of *Y. enterocolitica* cases occur among infants and children. In 2016, 16% (n=36) of all cases were reported among children younger than 4 years of age.

There is usually a peak in the number of reported cases during the summer, especially during July-August, but in the last four years there has also been a notable increase in the number of reported cases during January. The reason for this is not clear.

DISCUSSION

Yersiniosis is one of the zoonoses with the highest number of reported domestic human cases in Sweden. However since 2004, the number of reported cases has decreased not only in Sweden but also in EU as a whole. This decrease has occurred without any active interventions in the food chain.

In 2012, the case definition for laboratory criteria for yersiniosis was revised. The new case definition is thought to have had marginal effect on the decrease in the number of reported cases.

Yersiniosis in humans is considered foodborne. Outbreaks are rare and most infections seem to be

sporadic but under-reporting may be considerable. Approximately 75% of the infected cases are domestic. Case-control studies suggest that consumption of pork products is a risk factor. Thus good slaughter hygiene and good manufacturing practices in food processing are essential for control of *Yersinia*.

In 2013, a national 5-year strategy plan for human pathogenic *Y. enterocolitica* was published in order to identify measures that should be prioritised to decrease human incidence of yersiniosis. The strategy was developed in co-operation between the Swedish Board of Agriculture, National Food Agency, the Public Health Agency of Sweden, the National Board of Health and Welfare and the National Veterinary Institute.

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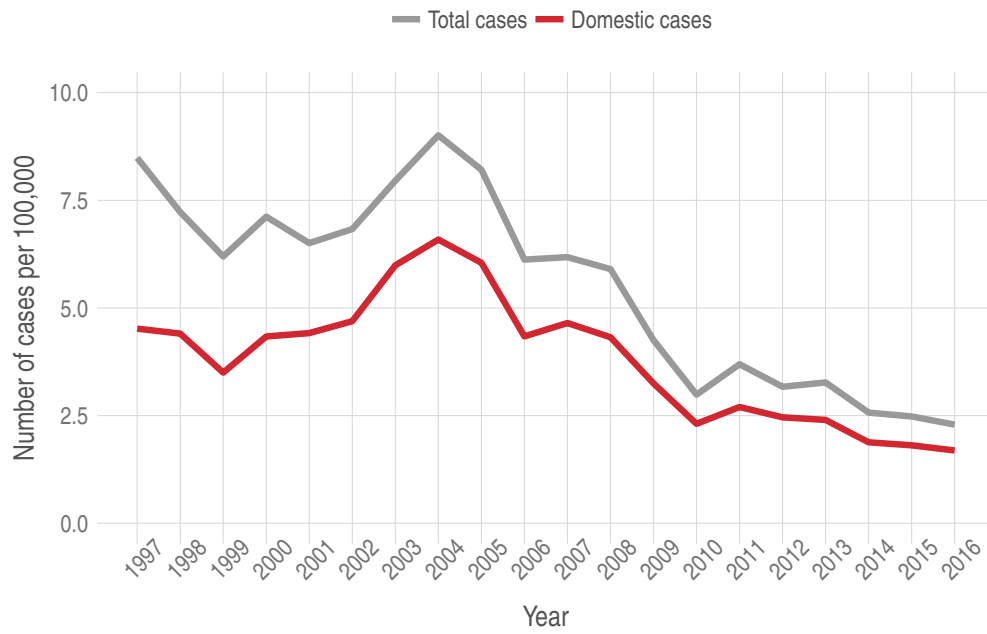


Figure 23: Notified incidence (per 100,000 inhabitants) of human cases of yersiniosis in Sweden, 1997-2016

Additional Surveillance 2016

Clinical surveillance

BACKGROUND

Clinical surveillance is a fundamental, passive, component of disease surveillance for both endemic and epizootic diseases. Especially in the case of epizootic and emerging diseases, early detection is of utmost importance in order to prevent spread and reduce the impact. For diseases with severe and obvious clinical signs, such as foot-and-mouth disease, African swine fever and anthrax, early detection is most efficiently achieved through clinical surveillance. For other diseases the clinical surveillance is complementary to active surveillance activities. In this chapter clinical surveillance of epizootic diseases is described. Specifically, passive surveillance approaches to foot-and-mouth disease, African swine fever and anthrax are described in more detail. Diseases with both passive and active surveillance components are presented in specific chapters.

Diseases

African swine fever

African swine fever (ASF) is a contagious disease of domestic and wild pigs, in its acute form characterised by haemorrhagic fever and high mortality rates. The disease is endemic in large parts of sub-Saharan Africa and on the Island of Sardinia, Italy, and since 2007 also in Caucasus and the Russian Federation. In the EU, ASF is now considered endemic in wild boar in parts of Estonia, Latvia, Lithuania and Poland, with sporadic outbreaks reported also in domestic pigs. The risk for further spread within EU is considered high. Because of the typically acute clinical course associated with the strains of ASF virus currently circulating in Eastern Europe with high mortality rates, early detection is most efficiently achieved through clinical surveillance.

Anthrax

Anthrax is a serious zoonotic disease that may affect most mammals, especially herbivores, as well as several species of birds. It is caused by *Bacillus anthracis*, a spore forming bacterium. The spores are highly resistant and may survive in the soil for decades. The disease was common in Swedish livestock in the beginning of the 20th century, with a

trend of significant reduction in frequency of outbreaks during the latter part of the century. During the last decade, however, the disease has re-emerged in the country with reported outbreaks in 2008, 2011, 2013 and 2016. The disease is endemic in most countries of the world.

Foot-and-mouth disease

Foot-and-mouth disease (FMD) is a highly contagious disease of cloven-hoofed animals such as pigs, cattle, sheep and goats. The mortality rate in FMD is low, but morbidity very high and convalescence is extended, which makes this disease especially important in countries previously free from the disease. FMD is endemic in many parts of the world, but since 2011 the disease is absent in Europe. However, the major FMD epidemics that affected several European countries during the last decade demonstrated that the continent is continuously at risk for FMD virus introduction, and that early detection is crucial.

LEGISLATION

Clinical suspicions of epizootic diseases must be notified to the Swedish Board of Agriculture in accordance with the Swedish Act of Epizootic diseases (SFS 1999:657 with amendments). This obligation applies to animal owners, veterinarians, veterinary laboratories, and other relevant stakeholders. Suspicions are investigated after consultation with disease experts at the National Veterinary Institute and following notification to the Swedish Board of Agriculture.

SURVEILLANCE

Every year, hundreds of suspicions of serious infectious diseases are reported by field veterinarians, animal owners or private veterinary pathologists to the experts at the National Veterinary Institute. Many of these suspicions can be ruled out already based on anamnesis and initial clinical investigation, whereas others require notification to the Swedish Board of Agriculture and further investigation including sampling of sick or dead animals, with movement restrictions imposed on the farms during the investigation. Also in cases in which an epizootic disease is not primarily suspected, but in which it cannot be excluded based on clinical investigation, samples

can be submitted for laboratory investigation to exclude a diagnosis. This can only be done after discussions with experts at the National Veterinary Institute and in consultation with the Swedish Board of Agriculture. This approach serves to reduce the threshold for submitting samples for analysis of notifiable diseases, and thereby increasing the sensitivity of the system. The Swedish Board of Agriculture covers all costs for veterinary visits, transports, and diagnostic analyses related to the investigation.

African swine fever

Reported cases of increased mortality or serious morbidity, with clinical signs such as haemorrhagic disorders or reproductive failures in pigs are considered suspicions of ASF until ruled out through further clinical investigation, with or without sampling of affected animals. Due to clinical similarity, samples from domestic pigs collected for ASF are also analysed for CSF. This strategy is strongly recommended by the EU.

Given the current situation in Eastern Europe as regards ASF in wild boar, Swedish hunters are encouraged to report findings of dead wild boar. If possible, samples are taken in to rule out ASF as the cause of death (see also specific chapter on infectious diseases in wild boar).

Anthrax

Reported cases with a history of sudden deaths in one or more animals on the premise are considered suspicions of anthrax. Clinical signs such as fever, bloody discharges from the nose, mouth, anus or vagina, uncoagulated blood, subcutaneous oedematous swellings and lack of rigor mortis, as well as recent site disturbances (dredging or digging) strengthens the suspicion.

Foot-and-mouth disease

Reported cases of disease in cattle, pigs, sheep or goats which presents with vesicular lesions of the feet, buccal mucosa or mammary glands, are considered suspicions of FMD until ruled out through further clinical investigation, with or without sampling of affected animals.

RESULTS

The suspicions of epizootic diseases that were reported and further investigated based on sampling of sick or dead animals in 2016 are compiled in Table 19.

Two clinical suspicions of ASF in domestic pigs were investigated. Samples were collected and sent to the National Veterinary Institute for PCR detection with negative result. Samples were also analysed for CSF and PRRS with negative results. Eighteen samples from wild boar found dead were also analysed for ASF with negative results.

One outbreak of anthrax was confirmed during the summer 2016 in the county of Östergötland involving six premises and in total 10 cattle, 1 sheep and 1 horse. In addition, three wild moose found dead in the outbreak area tested positive for anthrax. In total, 74 clinical suspicions of anthrax were investigated during the year, most of which were associated in time and space with the outbreak. Suspected cases were bled and samples sent to the National Veterinary Institute for examination using direct microscopy and multiplex RT-PCR. Carcasses were left on the premises, covered to prevent any direct contact with the carcass and possibly contaminated surfaces.

One clinical suspicion of FMD in a sheep herd, in which several animals suffered from erosions and vesicular lesions in the buccal mucosa, was investigated. Although the case was considered a low-grade suspicion, FMD could not be excluded based on clinical investigation. Samples were sent to the National Veterinary Institute for PCR and serology. All samples were negative and FMD could be excluded.

Newcastle disease was confirmed in one organic flock with 18,000 layers in the municipality of Vellinge in southern Sweden in November 2016. The flock presented with egg drop and egg abnormality and was detected within the clinical passive surveillance. The flock was culled and restriction zones established in accordance with EU legislation. The last restriction zone was lifted on December 15th 2016.

ADDITIONAL SURVEILLANCE 2016

Table 19: Number of suspicions of epizootic diseases reported through the clinical surveillance system during 2016 and investigated by experts at the National Veterinary Institute after notification to the Swedish Board of Agriculture.

Disease	Investigated ^A	Confirmed
African swine fever	20 ^B	0
Anthrax	74	15
Aujeszky's disease	2	0
Avian influenza	17 ^C	2 ^{C, D}
Bluetongue	2	0
BSE	2	0
Classical swine fever	5	0
FMD	1	0
Lumpy skin disease	1	0
Newcastle disease	17 ^C	1
Paratuberculosis	5	0
PRRS	5	0
Rabies	3	0
Tuberculosis	6	0
West Nile fever	1	0

^A In many cases, clinical suspicions were investigated for several diseases with similar clinical picture (e.g. ASF/CSF/PRRS, AI/ND)

^B Includes 18 samples from wild boar found dead, also described in the specific chapter on infectious diseases in wild boar

^C Does not include wild birds found dead

^D Described in the chapter on avian influenza

Poultry Health Control Programme

BACKGROUND

The aim of the Poultry Health Control Programme is to document freedom from the included diseases, to prevent the introduction and further spread of diseases and to allow trade from the participating companies.

The Poultry Health Control Programme is based on provisions (SJVFS 2010:58) issued by the Swedish Board of Agriculture. The programme is mandatory for all hatcheries producing more than 50,000 day-old chicks per year and all breeding establishments (grandparent and parent flocks of layers, broilers and turkeys) delivering hatching eggs to these hatcheries. In addition to serological sampling for several infectious diseases, the programme consists of rules on biosecurity, standards for poultry houses, management and clinical surveillance.

LEGISLATION AND DISEASES

All diseases in the programme, except for *Mycoplasma synoviae*, are notifiable according to provisions issued by the Swedish Board of Agriculture (SJVFS 2013:23). The diseases included in the programme during 2016 are briefly described below.

- Fowl typhoid and pullorum disease are two poultry diseases caused by *Salmonella enterica* subspecies *enterica* serovar Gallinarum biovar Gallinarum (*Salmonella* Gallinarum, fowl typhoid) and biovar Pullorum (*Salmonella* Pullorum, pullorum disease) respectively. These two biovars of the same serovar are specially adapted to poultry and vertical transmission is an important feature in addition to the common horizontal spread. Pullorum disease mainly affects fetuses and chickens up to 3 weeks of age while *Salmonella* Gallinarum commonly infects and causes disease (diarrhoea, inappetence, production losses and mortality) in older birds. Both biovars are included in the Swedish zoonosis legislation as well as in the European legislation on trade in poultry and hatching eggs (Council Directive 2009/158/EC). The diseases were eradicated from the Swedish commercial poultry population in the beginning of the 1960's. Since then, a single case of fowl typhoid (*Salmonella* Gallinarum) was detected in a backyard flock in 1984 and pullorum disease (*Salmonella* Pullorum) were detected in two backyard flocks in 2001 and four backyard flocks in 2012.
- *Mycoplasma gallisepticum*, *Mycoplasma synoviae* and *Mycoplasma meleagridis* are important poultry pathogens. However, *M. meleagridis* is only pathogenic for turkeys. These three mycoplasma types are able to spread both horizontally and vertically. They mainly cause respiratory disease and egg production losses. *M. gallisepticum* and *M. synoviae* may also cause arthritis and are present in the backyard poultry population in Sweden. Testing of breeding flocks for *M. gallisepticum* and *M. meleagridis* (only turkey flocks) is included in the European legislation on trade in poultry and hatching eggs (Council Directive 2009/158/EC). Due to its potential to cause disease and production losses, testing for *M. synoviae* was included in the programme between 1995 and 2010. During a revision of the programme the agent was excluded but is since the 1st June 2015 included again. In 2016, the analyses for *M. synoviae* were further intensified.
- Paramyxovirus type 1 may cause outbreaks of Newcastle disease, with egg production losses, increased mortality, nervous signs and respiratory disease; the severity of the disease may vary. The virus is transmitted through direct and indirect contacts with infected birds and for shorter distances also with the wind. Wild birds are an important reservoir. Since 1995, twelve outbreaks of Newcastle Disease have occurred in Sweden. The disease is included in the Swedish Act of Epizootic diseases (SFS 1999:657 with amendments). Since all outbreaks have been successfully eradicated, Sweden has a status of Newcastle free country without vaccination according to Commission Decision 95/98/EEC.
- Egg drop syndrome. The virus is a naturally occurring adenovirus in waterfowl (including the wild population) in which it does

ADDITIONAL SURVEILLANCE 2016

not cause any clinical disease. In chicken, the clinical signs are only seen during the production period as decreased egg production in an otherwise clinically healthy flock. The virus is able to spread both vertically and horizontally. The Swedish poultry breeding population is free from the disease.

SURVEILLANCE

Serological screening within the programme is administered by the National Veterinary Institute and financed by the Swedish Board of Agriculture and the participating companies. In 2016, seven different breeding companies participated in the programme; four broiler-, two laying hen- and one turkey breeding company. In accordance with the provisions of the programme, sixty blood samples were taken from the breeding flocks included in the programme, once during the rearing period and several times during the production period. The blood samples were sent by mail to the National Veterinary Institute where serological tests were performed. The sampling and testing schemes are presented in tables 20 and 21.

RESULTS

Table 22 gives an overview of all samples taken in breeding flocks of chickens and turkeys, and the laboratory methods used, during 2016. All analysed samples tested negative for *M. gallisepticum*, *M. meleagridis* and paramyxovirus type 1.

Antibodies against *M. synoviae* were detected in three chicken flocks (parent flocks). One of the

flocks was sampled at 60 weeks of age and no additional samples were available from this flock. In two other flocks, from the same farm, new samples obtained two weeks later were also positive for *M. synoviae*.

Fifteen chicken flocks (three grandparent and 12 parent flocks) were further investigated due to a few positive samples for egg drop syndrome. In addition, four chicken flocks (parent flocks) were investigated due to a few positive samples for *Salmonella Gallinarum/Salmonella Pullorum*. No clinical signs were seen in these flocks and after testing new samples from these flocks, the previous positive samples were considered as unspecific serological reactions.

DISCUSSION

In conclusion, the results from the serological screening in the Poultry Health Control Programme in 2016 support the status of freedom from several important infectious diseases in the Swedish breeding poultry population. However, the findings of *M. synoviae* antibodies in chicken parent flocks and possible implications on animal health and production both in parent and offspring flocks need to be further considered. *Mycoplasma synoviae* may spread both horizontally and vertically (from the hen to the chicken via the egg), hence infection in breeders may have consequences for the next generation as well. Infection may result in respiratory signs, articular disease and egg production losses. In addition, egg shell abnormalities associated with infection with *M. synoviae* have been reported.

Finally, the clinical surveillance of the poultry breeding population is also of utmost importance.

Table 20: Sampling schedule for chicken grandparent and parent flocks. Number of blood samples tested at different weeks of age.

Agent	Age in weeks				
	16	24	36	48	60
<i>S. Pullorum/ S. Gallinarum</i>	-	60	-	-	-
<i>Mycoplasma gallisepticum</i>	60	60	60	60	60
<i>Mycoplasma synoviae</i>	60 ^{A,B}	60	60 ^{A,B}	60 ^{A,B}	60 ^{A,B}
Paramyxovirus type 1	-	-	-	60	-
Egg drop syndrome-virus	-	30	-	-	-

^A Grandparent flocks

^B Parent flocks from March 1, 2016

Table 21: Sampling schedule for turkey parent flocks. Number of blood samples tested at different weeks of age.

Agent	Age in weeks			
	20	32	44	56
<i>S. Pullorum/ S. Gallinarum</i>	-	60	-	-
<i>Mycoplasma gallisepticum</i>	60	60	60	60
<i>Mycoplasma meleagridis</i>	60	60	60	60
<i>Mycoplasma synoviae</i>	60 ^A	60	60 ^A	60 ^A
Paramyxovirus type 1	-	-	-	60

^A From March 1, 2016

Table 22: Number of sampling occasions for grandparent (GP) and parent (P) flocks of chickens and turkeys and total number of samples tested during 2016.

Agent	No. of sampling occasions			No. of samples			Method
	Chickens		Turkeys	Chickens		Turkeys	
	GP	P	P	GP	P	P	
<i>S. Pullorum /S. Gallinarum</i>	13	70	4	780	4,200	240	Serum plate agglutination test, antigen, BioVac
<i>Mycoplasma gallisepticum</i>	0	45	3	0	2,700	180	ELISA MG antibody test, SVANOVA
<i>Mycoplasma gallisepticum / Mycoplasma synoviae</i>	62	319	13	3,720	19,140	780	<i>Mycoplasma gallisepticum/synoviae</i> Antibody Test Kit, ID.Vet
<i>Mycoplasma meleagridis</i>	0	0	16	0	0	960	Serum plate agglutination test, antigen, BioVac
Paramyxovirus type 1	12	69	4	720	4,140	240	NDV screen competition ELISA, ID.Vet
Egg drop Syndrome-virus	13	70	0	390	2,100	0	Antibody haemagglutination inhibition test, antigen, In House test

Infectious diseases in wild boars

BACKGROUND

Wild boars are susceptible to contagious diseases that affect domestic pigs and therefore they have a potential role in spreading diseases to and from domestic pigs. This is particularly the case for classical swine fever which has been transmitted between wild boars and domestic pigs in several European countries. The ongoing spread of African swine fever (ASF) from Russia and other countries in Eastern Europe into the EU involves wild boar, and the direct and indirect contacts between domestic pigs and wild boar in these areas hamper the control and management of the disease. The Swedish wild boar population is increasing rapidly and is presently estimated at 250,000 animals before the reproductive season of 2017. The northern border of the wild boar habitat is extending north and has at present passed the level of the river Dalälven. Since the year 2000, hunted wild boars from different parts of the country have been blood sampled yearly for surveillance purposes. The samples have been sent to the National Veterinary Institute for analysis for antibodies to infectious agents that are of importance for the domestic pig production. Due to the worrying situation regarding ASF in Eastern Europe and within EU, a passive surveillance for the disease in wild boars found dead has been included in the surveillance programme since 2013.

LEGISLATION

The infections investigated in the wild boar surveillance programme of 2016 are all included in the Swedish Act of Epizootic diseases (SFS 1999:657 with amendments) and are notifiable on suspicion. If any of them are suspected or confirmed, measures will be taken to control the disease and to prevent further spread.

SURVEILLANCE

Passive surveillance

Organ samples from, or whole carcasses of wild boar found dead were brought in for post mortem examination at the National Veterinary Institute. All submitted wild boars or samples thereof were subjected to African swine fever virus genome analysis irrespective of pathological lesions.

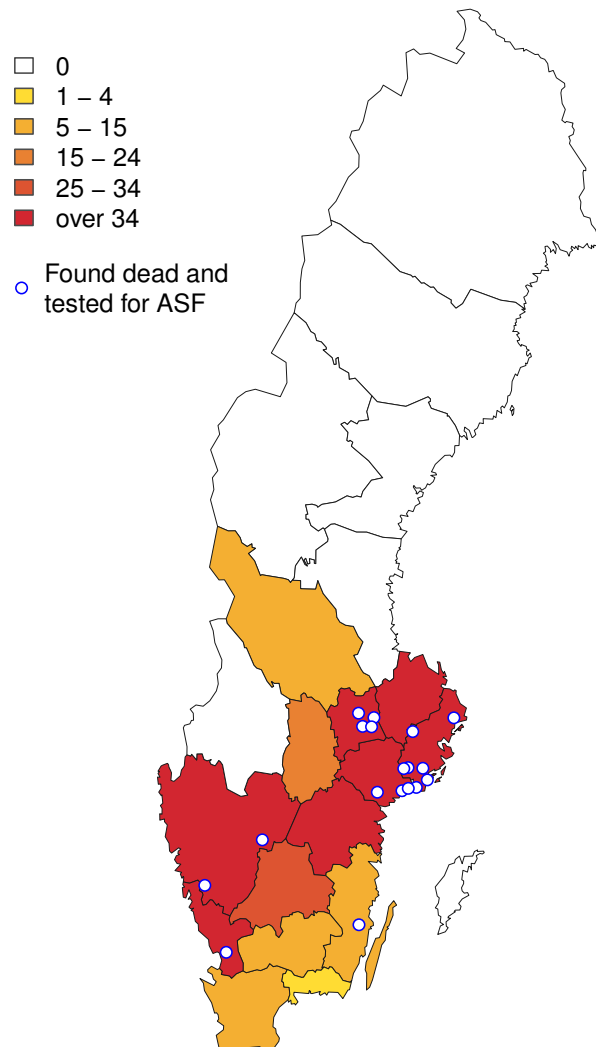


Figure 24: Geographical distribution per county of hunted wild boar that were sampled in 2016. The white points indicate locations where dead wild boars tested for African Swine Fever (ASF) were found. Administrative boundaries ©EuroGeographics.

Active surveillance

Blood samples from hunted wild boars were used for active surveillance of antibodies to Aujeszky's disease virus and classical swine fever virus. The samples were collected voluntarily by hunters recruited through information on the webpage of the National Veterinary Institute, in hunter's magazines and through using informal networks including information meetings. The surveillance was designed to detect the investigated diseases at 1% prevalence

with 99% confidence level. To reach this level of confidence 500 samples were needed. The samples were analysed using the serological methods described in the respective disease chapters in this report.

RESULTS

Passive surveillance

Eighteen wild boars found dead were examined for African swine fever virus genome and all analyses were negative. They were mostly found in the east part of the wild boar distribution area (Figure 24). Additional post mortem findings in these wild boars are reported in the chapter 'Post mortem examinations in wildlife' in this report.

Active surveillance

In 2016, 196 samples were collected from shot wild boars. The geographical distribution of sampled wild boars was roughly correlated to the distribution and density of the Swedish wild boar population (Figure 24). All analyses for Aujeszky's disease and classical swine fever were negative. The goal of 500 samples was not fully met, but the surveillance evidence was sufficient to indicate that the prevalence of the investigated diseases in the wildboar population was <2% with a certainty of 98%.

Discussion

The Swedish wild boar population is growing and the boundary of the population is moving north. In areas where wild boars already are present, the population is also becoming denser, which increases the risk of direct and indirect contact between wild boars and domestic pigs. The area in Sweden populated by wild boars is surrounded by sea border. Therefore, there is no risk of wild boars migrating into Sweden with disease. Instead, the role of the wild boar in disease spread might be to pick up infectious agents introduced into Sweden by other routes. It is possible that wild boars could gain access to infected meat or other infected animal products for example in garbage or following indirect spread by other means from people, vehicles or equipment. All diseases monitored in 2016 are or have recently been present in neighbouring countries or in close proximity to Sweden. The unfavourable development of the African swine fever situation in Russia, Eastern Europe and within EU is of special concern and calls for reliable methods for early detection of disease in the wild boar population.

Infectious diseases in fish, crustaceans and molluscs



Photo: Charlotte Axén

BACKGROUND

All registered aquaculture farming sites are obligated to participate in the Official Health Control Programme, regulated in accordance with SJVFS 2014:4, issued by the Swedish Board of Agriculture, and by Council Directive 2006/88/EG. Sweden has a very healthy aquaculture as well as wild populations of fish and shellfish. None of the serious diseases that occur throughout Europe are prevalent in Sweden. A restrictive approach to import of live fish for restocking/farming, an early introduction of health control in farms and the presence of hydroelectric dams in most Swedish rivers (acting as migration barriers for feral fish from the coastal zone) all contribute to maintaining this health status. The presence of dams also results in a different health status at the coast compared to the more disease free continental zone. To maintain this situation, all transport of live fish from the coast to the continental zone is forbidden and Sweden has a national conservation

programme for salmonids to compensate for the lack of natural migration.

DISEASES AND LEGISLATION

All Swedish fish farms have participated in surveillance for the diseases mentioned below since the late 1980's in accordance with EU Directives 2001/183 and 2006/88. Sweden has an approved disease free zone status (2002/308/EC) for Viral haemorrhagic septicaemia (VHS) and Infectious haematopoietic necrosis (IHN) (2008/427/EG). Additional guarantees are in place for the whole country for Spring Viraemia of Carp (SVC) and for the continental zone for Infectious Pancreatic Disease (IPN) (2010/221/EC). The continental zone of Sweden has an eradication programme for Renibacteriosis/bacterial kidney disease (BKD) and the coastal zone for IPN (2010/221/EU). These diseases are included in the Swedish legislation of notifiable diseases (SJVFS 2013:23). Further, IHN, VHS, IPN

(other than serotype ab) and SVC are included in the Swedish Act of epizootic diseases (SFS 1999:657 with amendments). In addition, sampling and diagnostics are routinely done for Koi herpes virus (KHV) in imported, quarantined koi, and Crayfish plague in Crayfish. These diseases are also regulated by the Swedish legislation for notifiable diseases (SJVFS 2013:23). Other notifiable diseases such as furunculosis (*Aeromonas salmonicida salmonicida*/ASS), yersiniosis/Enteric redmouth disease (ERM), Marteiliosis and Bonamiosis (shellfish) and Whitespot disease (Crayfish) are not actively tested for within surveillance programmes.

Infectious haematopoietic necrosis (IHN) and viral haemorrhagic septicaemia (VHS)

Both diseases are caused by rhabdoviruses and occur frequently in Europe. They are transferred horizontally, but vertical transmission cannot be completely ruled out for IHN. Both diseases have greatest impact in aquaculture of rainbow trout (*Oncorhynchus mykiss*) in freshwater, but have also been detected in several other species. Infected fish exhibit behavioural changes, lethargy and abnormal swimming (whirling). The fish are anaemic with varying degrees of bleeding in multiple organs. VHS is found in a marine form, and a low frequency in wild populations of sensitive species cannot be excluded in the Swedish coastal zone.

Infectious pancreatic necrosis (IPN)

IPN is caused by a Birnavirus that is highly infectious to juvenile salmonids. Susceptibility declines with increasing age. Fish that survive infection become subclinical carriers. In addition to salmonids, virus has been detected in several other species. The virus is transmitted both horizontally and vertically.

The disease has large consequences, with high mortality in young fish, and is considered as one of the most costly in several European countries. Symptoms include darkening, abdominal distension and corkscrew swimming. Bleedings in abdominal fat and internal organs are the most dominant internal findings. Mortality rates can vary between 10-90%.

Renibacteriosis (BKD)

BKD is caused by a gram positive bacterium, *Renibacterium salmoninarum*. The infection can be transmitted both horizontally and vertically. The disease favours low water temperatures, and outbreaks occur mainly at temperatures between 7-15

degrees.

Salmon and arctic char are most susceptible to BKD and mortality can reach 80%. In rainbow trout, the disease is chronic with a continuous low mortality of about 5-10%, however outbreaks of up to 40% mortality can occur. Infected fish may have reduced growth and disease can result in a deterioration of quality of the meat.

Spring viraemia of carp (SVC)

SVC is caused by a rhabdovirus. The disease occurs in Asia and several European countries. The virus has been detected in several fish species in the cyprinid family. The virus is transmitted horizontally. The clinical signs are usually general, such as darkening, exophthalmia and a slow breathing. The fish swim lazily with sporadic periods of hyperactivity. Other common findings are pale gills, ascites and haemorrhages in the skin and gills. Internally, bleedings are found in various organs including muscle, swim bladder and the brain.

Koi Herpes virus (KHV)

KHV is a DNA virus and affects common carp (*Cyprinus carpio*) and variants thereof, including koi. The virus was first detected in 1998 and has since then been reported from all continents except Australia. The virus is transmitted horizontally. KHV can cause severe problems and is associated with high mortalities. Infected fish usually swim at the surface and have an increased breathing frequency. Symptoms include enophthalmia, spotted gills and secondary bacterial or parasitic infections on gills and skin. Surviving carps can become subclinical carriers.

Crayfish plague

Crayfish plague is caused by an aquatic fungus (*Aphanomyces astaci*), which spread to Europe in the late 1800's from the U.S. with live crayfish. The disease occurs throughout Europe and North America. The fungus reproduces by spores spread in the water. When the spores infect crayfish they grow through the skin and attack the underlying tissues.

The signal crayfish becomes subclinically infected but may exhibit black (melaninated) areas in the shell adjacent to the presence of the fungus in the skin. The spots will disappear when the shell is shed, but may gradually reappear.

When noble crayfish is infected the first sign is high mortality in affected populations. Disease in the individual is characterized by behaviour changes

such as moving during daytime, reduced coordination and balance difficulties.

White spot disease (WSD)

WSD is caused by a Whispovirus (WSSv) that can infect a wide range of aquatic crustaceans including marine, brackish and freshwater prawns, crabs, crayfish and lobsters. Outbreaks occur at water temperatures of 18-30°C. The most common clinical sign is white spots in the exoskeleton, but the disease can occur without obvious external signs.

The virus is transmitted both horizontally and vertically and has a long survival time outside the host animal. The virus is present in imported frozen raw giant shrimps. There is a non-negligible risk that the virus will be introduced to the aquatic environment by anglers using these shrimps for bait. The consequences are difficult to predict but may have a negative impact on Swedish crustacean populations.

Marteiliosis

Marteiliosis, a disease in oysters and blue mussels, is caused by a unicellular parasite (*Marteilia refringens*). The parasite needs a crustacean (*Paracartia grani*) as an intermediate host. The disease causes reduced fitness, impaired growth and resorption of the gonads and hence reduced reproductive capacity. When the animals weaken, they cannot keep the shell halves closed. The parasite is considered to exist in two forms; the 'o' form, which occurs in oysters, and the 'm' form, which occurs in blue mussels.

Bonamiosis

Bonamiosis is a disease in oysters caused by the protistan parasite *Bonamia ostreae*. The parasite invades and destroys the haemocytes. Usually the only sign of disease is increased mortality in the infected oyster population. *B. ostreae* is found along the European Atlantic coast as far up as Denmark, where it has now been found in Limfjorden.

SURVEILLANCE

Within the Official Control Programme, there is active surveillance for the viruses causing IHN, VHS, IPN and SVC, and also for renibacteriosis/BKD. Sampling frequency is based on classification of each farm into one of three categories (high (I), medium (II) or low risk (III)) after a risk analysis, based on the risk for the farm becoming infected, the risk that the farm will further spread the pathogen

and the impact of the pathogen. The risk analysis and categorization is performed by the Board of Agriculture. Farms within risk category I and II are tested every year and every second year, respectively, but farms within risk category III are only tested upon suspicion of disease. The aim is to document freedom from disease and to contribute to the maintenance of this state.

There is also active surveillance in imported quarantined fish (eel - IPN and koi/carp - KHV). Active surveillance is also done when potential invasive alien species - like the marble crayfish - are discovered.

Crayfish plague is monitored by passive surveillance and analysis is done based on suspicion of disease outbreaks.

Except for the control programme, passive disease surveillance has been done through diagnostics related to disease outbreaks in farms and wild fish.

DIAGNOSTICS

All diagnostic analyses are performed according to recommendation by EU or OIE at the Swedish reference laboratory, the National Veterinary Institute. VHS, IHN, IPN and SVC are tested for on pooled organ material (spleen, kidney, heart/brain) by a cell culturing method. A pool consists of organs from up to ten fish. A cell culture is defined as virus positive if a cytopathogenic effect is detected within two weeks, after which the virus is identified by ELISA and confirmed by PCR or in some cases by serum neutralisation (SN test). KHV is tested for on individual fish (pooled gill and kidney) by PCR. Thirty fish are sampled in regular fish farms, and in compensatory breeding farms up to 120 fish are sampled after stripping of roe. In the case of carp/koi, only a few fish may be sampled. In eel quarantine as many as 120 fish are sampled.

In 2016, screening for other viral infections such as Infectious salmon anemia (ISA), Pancreas disease/Salmonid alphavirus (PD/SAV) and Heart and skeletal muscle inflammation/Piscine reovirus (HSMI/PRV) have been done in a few cases related to research or export.

BKD is tested for on kidney tissue from individual fish and demonstrated by an ELISA method. Verification is done by PCR. Thirty fish are sampled in regular farms, and in compensatory breeding farms up to 120 fish are sampled after stripping of roe.

A. astaci is demonstrated by light microscopy and cultivation and verified by realtime (rt) PCR,

and WSSv is detected by rt-PCR. The number of sampled animals varies from case to case.

RESULTS

Official health programme for fish farmers and crustacean surveillance

The number of samples analysed and results are shown in table 23. In summary, the active surveillance detected (one case=one outbreak):

- 1 case of IPNab in wild brown trout (Gullspångsöring) originating from Vänern (inland zone).
- 1 case of BKD in rainbow trout
- 6 cases of Crayfish plague

Voluntary health programme for fish farmers

There was one recorded outbreak of other notifiable diseases in fish during 2016, when furunculosis (ASS) was identified in an inland farm.

Outbreaks in wild fish, crustaceans and molluscs

Investigations into disease and mortality associated with external symptoms as skin hemorrhage and fungal infections in returning salmon indicated presence of herpesvirus and iridovirus in all eight samples analyzed by next generation sequencing (NGS), and Piscine reovirus, associated with Heart and skeletal muscle inflammation was identified in one fish by PCR. Immune histology is to be run to confirm the case. Yersiniosis/ERM was also identified in three fish from three different river systems. Otherwise, no specific pathogens were identified in the investigation. Mortalities in Eastern pearlshell (*Margaritifera margaritifera*) were investigated and indicated presence of freshwater protozoan microcell like parasites. Investigations to determine the species continue.

Two samples from Skagerak/Kattegat herring examined prior to export were positive for VHS genotype 1b.

DISCUSSION

The number of farms that were sampled are listed in table 23. Swedish aquaculture has a good health status, where all severe diseases of importance are absent. The most problematic disease to control is renibacteriosis/BKD, due to its vertical transmission and variable clinical presentation. Control of BKD is expected to be improved by modified sampling and improved methodology, from today's post mortem sampling to an in vivo method. Additional resources must be invested in risk based analysis of individual aquaculture farms to get a more reliable assessment for health surveillance.

In 2016, IPN of an unknown type was identified in a wild female broodfish, and for the first time in the inland zone. The virus showed only 80 % similarity to the closest BLAST hit on the VP2 gene. Thus, pathogenicity and potential impact on the salmonid population is unknown. Work is currently being done to sequence the full genome for correct classification. Prevalence investigations in Vänern will start during the year and infection trials to test pathogenicity are discussed. The importance of marine VHS genotypes in wild fish is difficult to interpret, and VHS genotypes, such as the identified 1b, pathogenic to rainbow trout are present in the Baltic Sea and Skagerak/Kattegat. In addition, and probably more important, fish farms importing roe or live fish pose a risk to introduce new pathogens into Sweden. Thus, there is risk that Sweden imports serious diseases not present in the country today. The official and voluntary control are keys to a quick identification and eradication in case such an introduction takes place.

The number of identified crayfish plague outbreaks have increased with 100 % between 2015 and 2016, and is back at the 2014 level. However, it is hard to interpret these results since surveillance is dependent on observation of disease. Also, in 2016, one specific county board took action to increase knowledge and take control of signal crayfish and the disease situation in their county. The action is based on the fact that the signal crayfish, carrying and spreading crayfish plague to royal crayfish populations, has now been listed as an invasive alien species in the EU.

ADDITIONAL SURVEILLANCE 2016

Table 23: Samples taken in the Swedish surveillance programmes for notifiable diseases in fish, crustaceans and molluscs

Disease	No. of sampled production sites	No. of infected production sites	No. of tested individuals	No. of tested pools	No. of infected individuals/pools
Fish					
VHS	80	0	-	667	-/0 ^D
IHN	80	0	-	497	-/0
IPN	80	0	-	497	-/1 ^B
ISAV	0		197 ^A	-	0
SVC	1	0	-	4	-/0
SAV	0	0	24 ^A	-	0
PRV1 & 3	0	0	95	-	1/-
KHV	1	0	4	-	0/0
BKD	68	1	2,657	-	16 ^C /-
Crustaceans					
<i>Aphanomyces astaci</i>	11 ^A	6	19	0	7/0
WSSv	1 ^A	0	1	0	0/-
Molluscs					
<i>Bonamia ostreae</i>	0	0	0	0	0
<i>Marteilia refringens</i>	0	0	0	0	0

^A wild fish/Crayfish

^B Virus isolation in cell culture, virus identified by ELISA and confirmed by RT-PCR and sequencing

^C By ELISA. Infection was verified in 5 of 5 fish that were further tested by qPCR. All positives were from the same farm.

^D Another 175 samples (herring, west coast) were run at EURL (Denmark), where one was confirmed infected (genotype 1b) by RT-PCR and sequencing and one was a strong suspicion by RT-PCR.

Abbreviations:

VHS	Viral hemorrhagic septicemia
IHN	Infectious Haematopoietic Necrosis
IPN	Infectious pancreatic necrosis
ISAV	Infectious salmon anaemia virus
SVC	Spring viraemia of carp
SAV	Salmonid alphavirus (Pancreas disease)
PRV1	Piscine reovirus (PRV1 causes Heart and skeletal muscle inflammation(HSMI))
KHV	Koi herpesvirus
BKD	Bacterial Kidney Disease

Examination of abortions in food producing animals

BACKGROUND

Postmortem examinations are considered an important part in the early detection and national surveillance for infectious and emerging disease. As mentioned in the part “Postmortem examinations in food producing animals”, the Swedish Board of Agriculture has for the past 20 years financed a programme for encouraging such examinations. Many infections, however, show no macroscopic lesions or cause nonspecific changes not detected at necropsy. Brucellosis, porcine reproductive and respiratory syndrome (PRRS) and classical swine fever (CSF) are examples of infections that may be present without specific macroscopic findings. Moreover, the clinical picture in the herd may be non-specific, which may cause a delay before the suspicion of these diseases occurs in clinical monitoring activities in the herds.

SURVEILLANCE

The surveillance component was introduced in 2008. It includes examinations for brucellosis in all ruminant foetuses and for brucellosis, PRRS and CSF in all pig foetuses submitted for necropsy as part of the post mortem examination programme. During the last parts of 2012 and 2013, Schmallenberg virus (SBV) was analysed as well. These infections often cause abortion, therefore sampling of aborted foetuses means sampling within a risk group and increases the chance of detecting the infectious agent if present in the country. The Swedish

Board of Agriculture finances sampling and testing of foetuses for *Brucella*, PRRS and CSF. All diagnostic testing was performed at the National Veterinary Institute. The foetuses were analysed for the CSFV and PRRS genome with PCR and *Brucella* by bacterial culture.

RESULTS

Since the start in 2008, various numbers of foetuses of different species have been examined each year (Table 24). The numbers for 2012 and 2013 were extraordinary high, most likely because of increased attention due to the newly identified infection with Schmallenberg virus (SBV).

All analysed samples were negative for both *Brucella*, PRRS and CSF.

DISCUSSION

The postmortem examinations and sampling of foetuses are an important part of the national surveillance for infectious and emerging diseases, as illustrated by the detection of infections with Schmallenberg virus in 2012 and 2013. Testing for SBV ended in 2013 because the disease, at that time, had become established in Sweden and therefore was considered endemic. During the last three years the number of examinations has been less than the anticipated, approximately 140 foetal examinations per year. Actions have been taken to increase the numbers during 2016, for example improving awareness by reminding about examinations to herd veterinarians. These actions will continue during 2017.

Table 24: Number of examined foetuses in the surveillance since the start of 2009

Species	2009	2010	2011	2012	2013	2014	2015	2016
Cattle	15	62	21	63	114	32	29	34
Goat	0	9	3	5	4	2	0	2
Sheep	29	70	45	79	89	28	31	16
Alpaca	2	5	0	0	4	0	2	1
Bison	0	0	0	1	1	0	0	1
Gnu	0	0	0	0	1	0	0	0
Visent	1	0	2	1	0	0	0	0
Pig	79	61	51	54	46	31	17	43
Total	126	207	122	203	259	93	79	97

Post mortem examinations in food producing animals

BACKGROUND

Early detection of infectious diseases is of utmost importance to prevent negative effects. For diseases with severe clinical signs the first line of defence is the detection of disease by animal owners, field veterinarians and pathologists. International and national experience, show that post mortem examinations remain a vital part in disease control and detection of emerging diseases.

As post mortem examinations are considered an important part in the early detection and national disease surveillance, a specific programme for such examinations, by financial means, started in the early nineties. The Swedish Board of Agriculture finances the programme, with support of fees from the animal owners. Farm & Animal Health is responsible for the organisation of the post-mortem examination programme.

PROGRAMME

The programme subsidises post mortem examinations in all food producing animals, including poultry. The latter were included in the programme in 2007. Since 2008, domesticated exotic ungulates are also included. Approximately 3,000 animals have been examined yearly within the programme since 1999. In conjunction with post mortem examinations, samples are routinely collected from defined categories of animals for surveillance of salmonellosis, paratuberculosis, PRRS, CSF, brucellosis, TSE and antimicrobial resistance.

The programme also includes further education of veterinarians and the veterinary employees at the post mortem facilities. Yearly courses are held and quarterly newsletters are produced.

Transportation of the carcasses to the laboratories is arranged and financed by the owner. This can be a problem for large animals, particularly when the distance between the farm and post mortem facility is long.

RESULTS

During 2016 post mortem examinations were performed at five different sites, all located in the southern half of Sweden: Skara (Eurofins Food & Agro),

Kristianstad (Eurofins Food & Agro), Uppsala (the National Veterinary Institute and the University of Agriculture), Visby (Farm & Animal Health) and Karlskoga (Farm & Animal Health). Large animals, such as adult cattle, were examined at four of these sites, Uppsala, Kristianstad, Karlskoga and Visby. A total of 2,837 post mortem examinations were performed within the programme during 2016.

The distribution of species examined over the last 10 years are shown in table 25. The variation in the number of animals submitted for post mortem examination within the largest livestock producing sectors (pigs, cattle, sheep and poultry) is illustrated in figure 25.

In 2016, 94 cases were diagnosed with a notifiable disease at post-mortem examination. Table 26 shows the number of reported index cases of notifiable diseases.

DISCUSSION

The post-mortem examinations are a vital part of the national surveillance for infectious and emerging diseases, as illustrated by the detection of 94 index cases of notifiable disease in 2016. Post mortem examination is also an important tool for the veterinarians to solve animal health problems at the individual farm. In the last decade, the number of post mortem examinations has been around 3,000 per year, with a steady decline in pigs and an increase in poultry. For 2016, there is a slight increase in pigs and ruminants with a bit fewer poultry being examined but still around 3,000 animals.

A regional imbalance can be seen in that more examinations are performed in the relatively few regions with local post mortem examination facilities. The highest numbers of examinations are performed in regions with high animal density and access to a regional laboratory performing post mortem examinations.

Distance and transportation method to facilities where post mortem examinations can be performed is important for quality reasons. A long delay before cold storage and examination will result in more cadaverous changes and will influence

the quality of the post-mortem examination negatively. A project financed by the Swedish Contingency Agency on improving transportation and logistics for transportation of dead animals submitted for post mortem, to improve quality of the examinations, was initiated in 2014 and was continued through 2015. The project resulted in better logistics and less carcasses affected by cadaverous changes. After the project in 2014-15, the laboratories, veterinarians and farmers expressed a wish to make the transportation pilot project a permanent solution, which has been achieved in 2016. The new car designated for transportation to post-mortem only is now partly funded with an extra fee

which so far has been accepted by the farmers.

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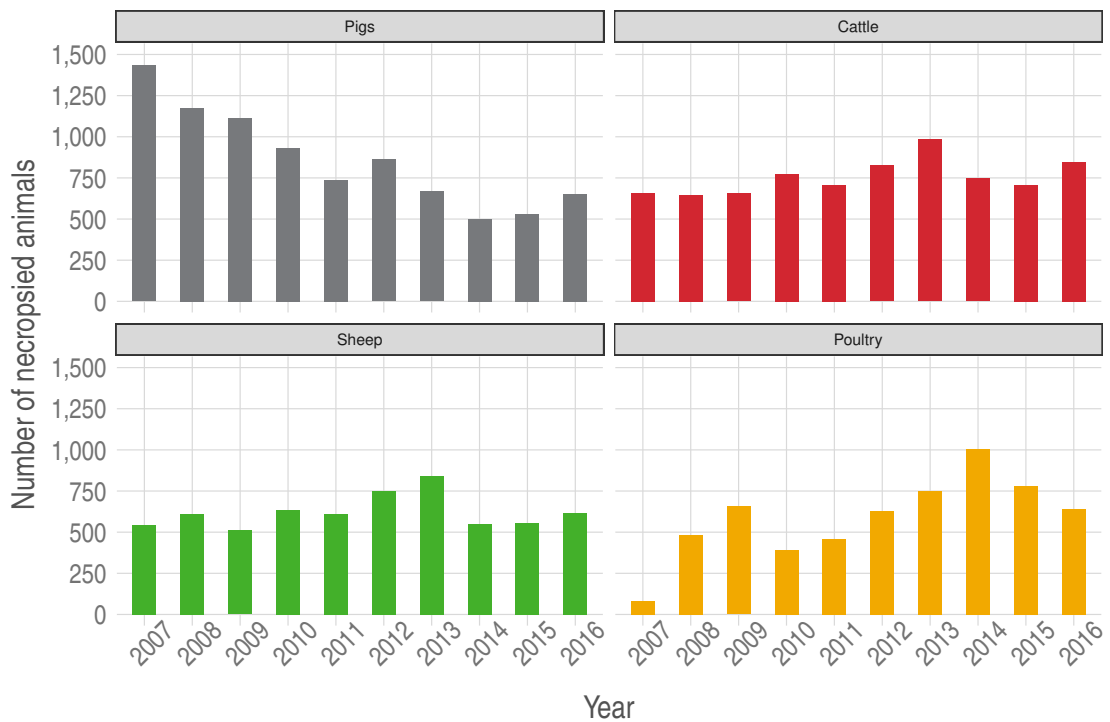


Figure 25: Number of necropsies by selected animal species over a 10 year period

ADDITIONAL SURVEILLANCE 2016

Table 25: Number of submissions to post mortem examination of food producing species, 2007-2016.

Year	Pigs	Cattle	Sheep	Goat	Farmed deer	Poultry	Exotic ungulates	Other	Total
2007	1,434	660	545	17	39	80	7	-	2,782
2008	1,173	646	613	15	43	480	10	1	2,981
2009	1,112	655	510	11	10	656	18	5	2,977
2010	932	773	637	24	13	391	25	2	2,797
2011	737	707	611	23	11	460	28	1	2,578
2012	862	826	749	35	11	630	37	1	3,151
2013	667	983	840	34	18	749	43	2	3,338
2014	502	747	548	14	11	1,006	40	0	2,868
2015	529	707	557	21	3	778	42	3	2,640
2016	651	845	617	34	17	642	31	0	2,837

Table 26: Number of index cases of a notifiable disease 2011-2016, diagnosed from samples taken at post mortem examination.

Disease	2011	2012	2013	2014	2015	2016
Anthrax	1	0	0	0	0	1
Avian rhinotracheitis	-	-	1	0	0	0
Avian tuberculosis (poultry) ^A	2	1	-	-	-	-
Blackleg	7	8	7	4	19	26
Bovine Malignant Catarrhal fever	0	1	3	1	1	6
Duck Viral Enteritis ^B	-	-	-	1	0	0
Fowl Cholera (pasteurellosis)	2	0	0	0	0	3
Fowl typhoid (<i>S. Gallinarum</i>)	0	1	0	0	0	0
Infectious Bronchitis	2	4	0	0	0	0
Infectious laryngotracheitis	16	17	36	35	26	26
Influenza, pigs	0	3	1	1	0	0
Influenza A typ (H1N1) 2009	-	-	3	0	0	0
Listeriosis	35	38	49	31	22	20
Lymphoma (not EBL)	7	11	0	0	0	2
<i>Mycoplasma gallisepticum</i>	0	3	0	4	4	0
<i>Mycoplasma</i> , poultry (notgallisepticum)	2	3	0	0	0	2
Necrotic haemorrhagic enteritis (<i>Clostridium perfringens</i> type C)	0	1	0	0	0	0
Salmonellosis	4	3	2	3	3	1
Total	78	94	102	80	75	88

Statistics from Farm & Animal Health.

^A this disease is no longer notifiable since November 2012, thus one case previously reported was removed from 2012.

^B This disease was not previously diagnosed in Sweden.

Post mortem examinations in wildlife



Photo: SVA

BACKGROUND

A general surveillance programme for diseases of wildlife based on pathology and ancillary testing was established in Sweden in the late 1940s. The surveillance programme is financed partly by annual hunting permit fees, and partly by governmental funding. The aim of the general and targeted wildlife disease surveillance programmes is to monitor the health status of wildlife in Sweden, as well as presence or absence of diseases. The mission is to diagnose and acquire knowledge on present and emerging diseases in Swedish wildlife. The disease surveillance and diagnostics provide key information for wildlife management. It is also part of zoonotic and epizootic disease surveillance efforts and can serve as an indicator of environmental and ecosystem health. The National Veterinary Institute is the only laboratory in Sweden where post mortem examination of fallen wildlife is performed. SVA is also the national wildlife focal point for OIE and

submits reports of OIE-listed diseases in wildlife, as well as OIE-specified non-listed wildlife diseases.

SURVEILLANCE

The general public, local authorities, and especially hunters submit wildlife that is found dead, or found sick and then euthanized, to the National Veterinary Institute for examination. This includes fallen wildlife and standard samples collected from hunted large carnivores or other game species within research projects and bio-bank sampling. Hunter-harvested wild boar and brown bear (*Ursus arctos*) samples for *Trichinella* analysis are not included in these numbers. All large carnivores: brown bear, lynx (*Lynx lynx*), wolf (*Canis lupus*) and wolverine (*Gulo gulo*), found dead, euthanized or shot in licensed hunting are submitted to SVA for necropsy as skinned carcasses or tissue samples. Whenever possible, disease causing agents are identified and cause of death established.

ADDITIONAL SURVEILLANCE 2016

RESULTS

In 2016, 1,525 wild animals, parts or whole carcasses were submitted and examined at the Department of Pathology and Wildlife Diseases.

In 2016, notable wildlife disease outbreaks were rabbit hemorrhagic disease caused by the new RHDV type 2 virus in wild rabbits in the southern half of the country and high pathogenic avian influenza virus type H5N8 reaching Sweden in November, with mainly waterfowl but also white tailed eagles and other scavenging raptors affected. Following the finding of chronic wasting disease (CWD) in neighbouring Norway, CWD screening of fallen or euthanized sick cervids was initiated also in Sweden. Around 100 Swedish cervids were

tested in 2016, all were negative. For more details, see the CWD chapter.

DISCUSSION

The general disease surveillance in wildlife is based on citizen science, with the interested public and hunters especially, reporting and submitting samples. A high public interest in wildlife health and conservation continues to make this work possible. Among the health care community and relevant authorities, it is well recognised that wildlife disease surveillance is an integral part of the One Health concept. The wildlife disease surveillance results (Table 27) show that Sweden has few serious infectious disease threats.

Table 27: OIE non-listed wildlife diseases and number of outbreaks/cases reported to the OIE for 2016.

Disease	Number of cases	Species affected
Avian influenza (H5N8)	18	Goshawk (1), Herring gull (2), Mallard (1), White-tailed eagle (4), Goldeneye (1), Crow (2), Buzzard (1), Magpie (2), Black-headed gull (2), Tufted duck (1), Sparrowhawk (1)
Calicivirus (EBHS)	2	European brown hare
Fowl pox	1	Rock pigeon
Listeriosis	1	Fallow deer
Myxomatosis	2	Wild rabbit
Paramyxovirus (PMV-1)	5	Rock pigeon
Pasteurellosis	1	Fallow deer
Pseudotuberculosis	4	European brown hare (3), Mountain hare (1)
Rabbit Hemorrhagic Disease (RHD)	44	Wild rabbit (43), Mountain hare (1)
Sarcoptic mange	15	Lynx (6), Wolf (8), Wild boar (1)
Salmonellosis	32	Bullfinch (19), Common redpoll (5), Greenfinch (1), Siskin (2), Green woodpecker (1), Hedgehog (2), Great spotted woodpecker (1), Great tit (1)
Toxoplasmosis	2	European brown hare
Trichomoniasis	1	Rock pigeon
Trichinellosis	15	Brown bear (1), Lynx (7), Red fox (1), Wolf (3), Wild boar (3)
Tularemia	6	European brown hare
Total	149	

Antibiotic resistance in bacteria from animals and food

BACKGROUND

The National Veterinary Institute (SVA) has the assignment from the Ministry of Agriculture to monitor and analyse the development of antimicrobial resistance in bacteria from animals and from food of animal origin. Also, the European Commission has decided on mandatory harmonised monitoring of antibiotic resistance in bacteria from food-producing animals and food thereof. The monitoring activities are carried out through the Swedish Veterinary Antibiotic Resistance Monitoring Programme (Svarm), which has been running since 2000.

The objectives of Svarm are to detect trends in resistance and to provide a basis for recommendations on the use of antibiotics in animals. Three types of bacteria are monitored: zoonotic bacteria, specific animal pathogens and indicator bacteria from healthy animals and meat. In addition, intestinal content from healthy farm animals and fresh meat thereof are screened for *E. coli* producing extended spectrum beta-lactamases (ESBL), AmpC-enzymes and carbapenemases. The rationale for monitoring indicator bacteria, i.e. commensal *Escherichia coli* and *Enterococcus* spp. from the normal intestinal flora of healthy animals, is that resistance among these bacteria reflects the selection pressure caused by the use of antibiotics in an animal population. These commensal bacteria can also be a reservoir of mobile resistance genes that can reach humans through the food chain. Thus, the prevalence of resistance in bacteria that contaminate meat indicates the magnitude of the potential human exposure to such reservoirs in food producing-animals.

The Svarm programme adheres to the instructions for the mandatory monitoring of resistance in EU according to directive (2003/99/EG) and subsequent decisions (2013/653/EU). According to the directive, resistance in *Salmonella*, *Campylobacter jejuni* and in indicator bacteria shall be regularly monitored in broilers, pigs and cattle using harmonised methodology. Briefly, for Sweden this implies that each year, isolates of *Salmonella* from all notified incidents and 100-200 isolates of *Campylobacter* from either broilers, pigs or calves are

tested for antibiotic susceptibility. Also, each year 170 isolates of *E. coli* from intestinal content of healthy broilers or from pigs and cattle are tested. In addition, each year 300 samples of intestinal content and 300 samples of fresh retail meat from either broilers or from pigs and cattle are screened for ESBL/AmpC- and carbapenemase producing *E. coli*.

In addition to this mandatory monitoring, Svarm is complemented with data on resistance for clinical isolates of bacteria from the routine testing of clinical submissions at SVA. Svarm is also complemented with data from research projects and specifically from the SvarmPat project focusing on resistance in animal pathogens from farm animals. SvarmPat is run in cooperation with Farm and Animal Health and is financed by the Swedish Board of Agriculture.

Results of Svarm, i.e. data on antimicrobial resistance in bacteria from animals and food are presented in a yearly report together with data on sales of antimicrobials for use in animals. These results are published together with corresponding data for human medicine from the Swedres programme at the Public Health Agency of Sweden (FoHM) in a fully integrated report - Swedres-Svarm - available at www.folkhalsomyndigheten.se or at www.sva.se (Figure 26).

SUMMARY SVARM 2016

The situation in Sweden regarding antibiotic resistance in bacteria from humans and animals is still favourable from an international perspective. This confirms that strategies to promote the rational use of antibiotics and to limit the spread of antibiotic resistance are effective. In the last decades, the consumption of antibiotics in Sweden has decreased in both humans and in veterinary medicine. In addition, the sales of broad-spectrum antibiotics have decreased while the use of narrow-spectrum antibiotics has increased. Despite this, most of the monitored types of antibiotic resistance have continued to increase since national surveillance began in the late 1990s.

Antibiotic sales in veterinary medicine

In 2016, reported sales of antibiotics for animals were 10,543 kg, of which 57% were for benzyl penicillin. The corresponding figures for 2007 were 17,106 kg and 44%, respectively.

Since the withdrawal of growth-promoting antibiotics from the market in 1986, the total sales of antibiotics have decreased by two thirds when corrected for different population sizes over time. During the 1990s, sales of veterinary products for medication of groups of animals decreased, and in the past decade there has also been a decrease in sales of products for use in individual animals.

Extended spectrum beta-lactamase (ESBL) producing Enterobacteriaceae

ESBL-producing *Enterobacteriaceae* are, with the exception of broilers, rare among animals in Sweden. In 2016, the occurrence of ESBL-producing *E. coli* in intestinal and meat samples from broilers and from intestinal samples from turkeys was investigated with screening methods. Such bacteria were isolated from 42% of the intestinal samples and 44% of the meat samples from broilers of Swedish origin. The occurrence in intestinal samples from broilers was comparable with 2015. Changes in the screening methodology prevent any direct comparisons with the figures from previous years and for the occurrence in meat. For the first time in Svärm, ESBL-producing *E. coli* was also detected in one (1%) of the intestinal samples from turkeys.

Methicillin resistant *Staphylococcus aureus* (MRSA)

The occurrence of MRSA in animals in Sweden is still low, which limits the spread from animals to humans. MRSA was found sporadically in dogs and cats in 2016, and MRSA with *mecC* was detected in samples from several goats and sheep in an outbreak at a zoo. In companion animals, the same types of MRSA as in humans dominate, indicating a human source of MRSA in these animals. In horses, livestock-associated MRSA CC398 is the most common.

Methicillin resistant *Staphylococcus pseudintermedius* (MRSP)

In 2016, the number of notified cases of methicillin-resistant *Staphylococcus pseudintermedius* (MRSP)

was on the same level as 2015. In total, 55 cases were notified in 2016, which can be compared to 60 cases in 2015 and 39 cases in 2014. All cases except two were related to dogs. The picture of MRSP is becoming more diverse compared to earlier years, although the ST71-t02-SCCmecII-III lineage is still common. The emerging clone ST258 only constituted 9% of cases in 2016 compared to 33% of notified cases in 2015. Furthermore, a new MLST variant, ST551, was identified in 11% of cases in 2016.

Resistance in zoonotic pathogens

Salmonella is rare in animals in Sweden, and few incidents involve antibiotic-resistant strains. Strains with ESBL resistance have never been found in isolates from animals in Sweden, and resistance to fluoroquinolones is rare. Isolates from human invasive infections are markedly more resistant, which makes animals in Sweden an unlikely source for these infections. *Campylobacter* from animals in Sweden are mostly susceptible, and resistance to erythromycin, for example, is most uncommon.

Resistance in animal clinical isolates

Bacteria causing clinical disease in animals are mostly susceptible to antibiotics relevant for treatment. Respiratory pathogens from farm animals and horses are generally susceptible to benzylpenicillin, but penicillin resistance is common in *Staphylococcus pseudintermedius* from dogs and occurs in *S. aureus* from horses and *Staphylococcus felis* from cats. Resistance in *E. coli* occurs in all animals but is most prominent in enteric isolates from young calves. Susceptibility testing for guidance in antibiotic therapy is warranted, especially for staphylococci and *E. coli*.

Resistance in indicator bacteria from healthy animals

Antibiotic resistance in *E. coli* from the intestinal flora of healthy animals serves as an indicator for the presence of resistance in an animal population. The prevalence of acquired resistance in such commensal bacteria also indirectly indicates the magnitude of the selective pressure from the use of antibiotics in an animal population. The prevalence of resistance in indicator bacteria from animals in Sweden is low, and the situation is favourable in an international perspective.

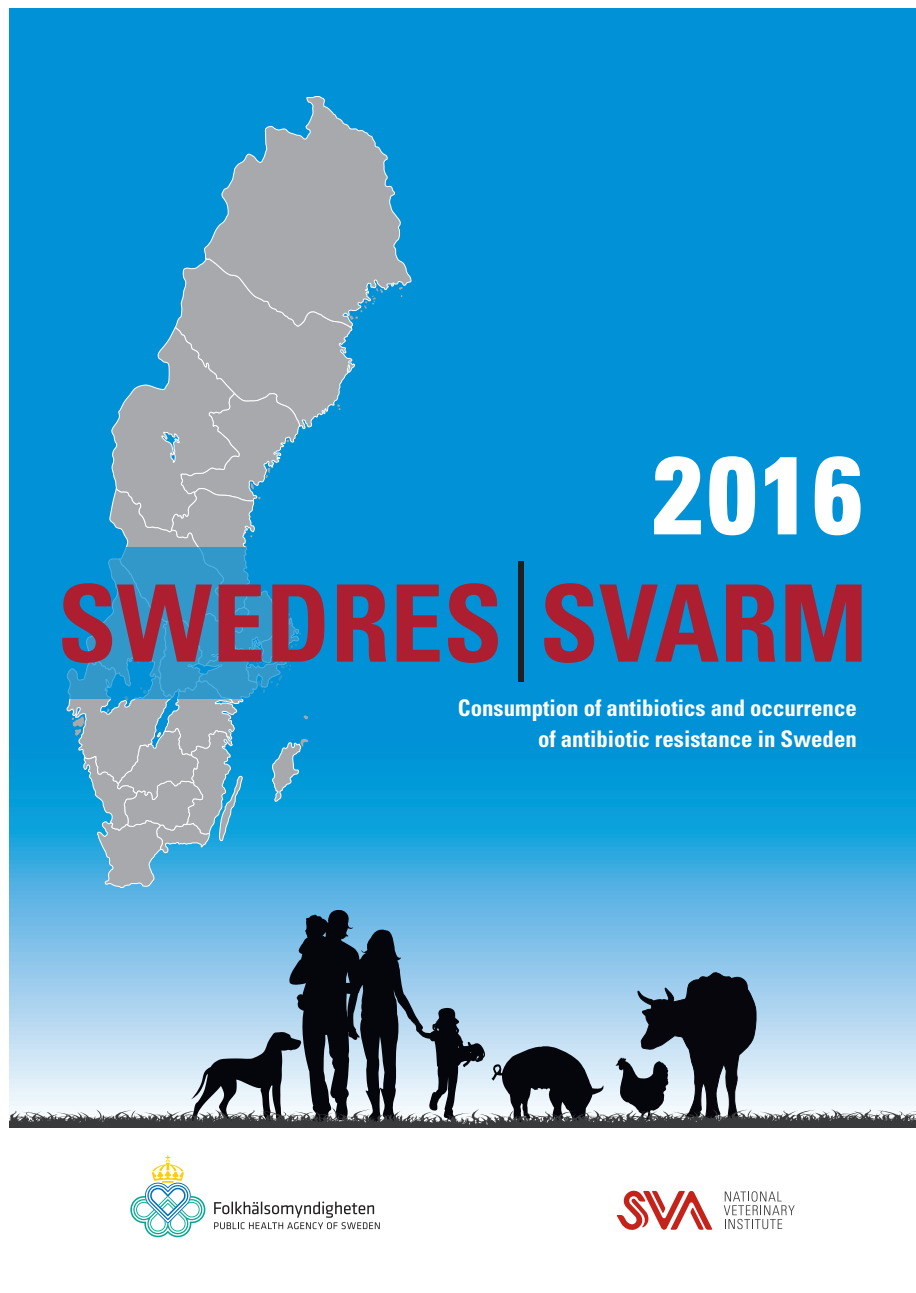


Figure 26: Download the report at www.folkhalsomyndigheten.se or at www.sva.se

