Johne's disease control – are there lessons we can learn from the UK?

What can we learn from progress with Johne's disease control in the UK which would benefit Ireland, asks Peter Orpin, director, Myhealthyherd.com, Park Veterinary Group; and Dick Sibley, director, Myhealthyherd.com, West Ridge Veterinary Practice, UK

The national control of infectious disease is an increasingly important part of modern farming practices. The drive to improve technical efficiency, while producing safe, healthy wholesome food for which the consumer is willing to pay a premium price, has driven retail and processor groups in the UK to take a more robust interest in farm animal production.

One key area of interest has been Johne's disease (JD) within the dairy sector, not least due to the potential human-health issues. This has led to the creation of a UK National Johne's Management Plan (NJMP) with a clear focus to reduce the incidence of the disease nationally. However, the history of large-scale JD schemes internationally has been disappointing.

A comprehensive review of six major countries attempts to manage large-scale JD schemes was undertaken in 2014[2] highlighting several differences in the strategic approach to control; herd-classification methods; recommended control measures; and responses to shared challenges. Commonly, rigid prescriptive schemes only worked when heavily subsidised and then collapsed when financial subsidy was removed. One of the more successful industry-led schemes was the Danish control programme using quarterly milk testing and risk management, which engaged farmers producing over 30% of dairy produce.[3] The Dutch have also managed to implement and maintain a robust national programme with a clear aim of reducing Mycobacterium avium subsp paratuberculosis (MAP) in milk, and driven by market mechanisms.

WHAT CAN WE LEARN FROM THE UK?

JD management in the UK was originally based on the voluntary scheme rules of Cattle Health Certification Standards (CHeCS). This herd-classification scheme used biosecurity and sampling rules to define an absence of disease with reasonable confidence. In the 1990s, the scheme gave the opportunity for herds with higher prevalence to join, with a strategy of identifying and culling infected animals to reduce prevalence. Uptake by the dairy sector was low, due in part to the high cost of blood-testing cattle and inflexibility of the scheme rules, with the emphasis on an expensive and sometimes ineffective test and cull strategy as the control method.

In 2007, a web-based health-management program, Myhealthyherd.com (MHH), was launched within the UK allowing vets, farmers and monitoring organisations to

General biosecurity risks relevant to Johne's disease n = 2,993 dairy herds	Frequently	Occasionally	Never
The herd introduces cattle on to the farm	13.7%	62.1%	24.2%
Cattle share grazing or buildings with cattle of unknown disease status	2.9%	8.2%	88.9%
Slurry or farmyard manure is from another farm is spread on land	0.6%	4.9%	94.5%
Cattle have access to waterways that have passed through another livestock farm	14.5%	38.7%	46.8%
Cattle are fed with feeds that could have had contact with other animals	1.8%	16.1%	82.2%

Johne's disease specific biosecurity risks n=2,296 dairy herds			
The herd has introduced groups of animals of unknown Johne's status in last 10 years	13.4%	39.6%	47.0%
The herd has introduced individual animals of unknown Johne's status over last 10 years	11.0%	57.8%	31.2%
Slurry of farmyard manure from another farm is spread onto youngstock pastures	0.4%	4.2%	95.4%
Calves have access to streams or watercourses that have passed through another livestock farm	6.6%	28.2%	65.2%
Youngstock graze pastures that are heavily infected with rabbits	13.8%	48.9%	37.3%
Youngstock co-graze pastures with sheep of unknown disease status	8.0%	21.9%	72.1%
Calves are fed on colostrum from other herds that may be high risk of carrying MAP	2.0%	4.0%	94%

Figure 1: Biosecurity risks in UK dairy herds collated by the Myhealthyherd.com JD program.

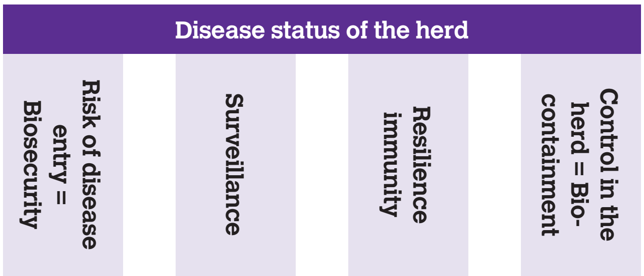

Figure 2: The four pillars supporting the disease status of a herd.

of MHH was to make herds healthier using a principle of identifying and managing disease risks at herd level and included modules for infectious-disease management, as well as economic evaluation. The program measured and analysed disease-specific risks using algorithms to create a traffic-light system of categorisation and then ranked individual risks to enable prioritisation of control. The program enabled the farmer and vet to identify farms at risk of developing diseases rather than simply monitoring disease once established. This promoted a 'predict-and-prevent' approach to disease management, particularly useful for the control of chronic diseases with poor-testing sensitivities such as Johne's disease. Even farms with low prevalence, or where disease was not considered to be a problem, became engaged in preventive strategies, understanding the implications of their disease risks. A prevalence-prediction tool was added allowing current-test prevalence to be converted into a predicted true-herd prevalence to drive further engagement. The MHH program was used as the tool to deliver funded regional health programmes (Healthy Livestock Initiative, Northwest Regional Development Agency). This flexible approach proved to be central to the development of NJMP.[4]

The analysis of disease risks was enlightening. Any large-scale JD scheme needed to be applicable to the highly variable farming systems to ensure engagement and sustainability. For example, of 2,293 herds using the system, 54% of herds had introduced groups of animals of unknown JD status in the last 10 years. Only 24% of farms never introduced cattle to the farm.[4] Any national scheme would have to adapt to, and manage those established trading patterns rather than attempt to change them.

Myhealthyherd.com uses a principle of herd-disease management based on four pillars of control: biosecurity (risk of disease introduction); biocontainment (risk of disease spread within the herd); resilience (immunity, vaccination); and surveillance.[7]

Traditionally, infectious-disease control had a strong emphasis on surveillance (testing to determine prevalence and identify infected animals) and less emphasis on the three other pillars. Simply testing large number of animals alone will not control disease. Testing, without regard to biosecurity, biocontainment and resilience, had failed to control both JD and bovine tuberculosis internationally.

However, dramatic changes in farming practices would not be accepted by the farming world, and often the aspirations and obligations of disease eradication were not shared by those who were expected to deliver it. Theoretical price premiums for classified or certified low-risk stock rarely materialised, and international JD scheme faltered when subsidies were removed.

So. how could we engage the farmers and wider industry in effective JD control?

JOHNE'S ENGAGEMENT PROGRAMME 2009-2015

Dairy UK (a UK national organisation representing milk processors) responded to some industry and market pressures by creating a Johnes' Action Group of vets, laboratories and processors to tackle the disease. The focus on the early years was on education and awareness. Over 300 processor-funded farmer meetings took place focusing on dispelling myths and explaining how the disease could be practically and effectively prevented and controlled.

Herd prevalence was estimated using targeted 30 cow-milk ELISA tests of high-risk animals as part of the awareness programme, sometimes subsidised by processors or farming groups. This simple, cheap, herd-surveillance system was well-received with a sensitivity shown to be 85%.[1]

Parallel vet continuing professional development (CPD) took place in order to engage what was sometimes a sceptical veterinary profession. This education had a clear focus on preventing infection in low-prevalence herds and offering flexible and appropriate control-strategy options that could be adopted by any herd in any situation. Based on the options offered with the Myhealthyherd Johne's management system, six control strategies were developed which would allow any farm to engage in the national programme: biosecurity protect and monitor, improved farm management (IFM); IFM and strategic testing; IFM and test and cull; breed to terminal sire; and firebreak vaccination. The choice was veterinary-driven and was dependent on farmer aspiration, resources, risks and prevalence.

DEVELOPMENT OF NJMP 2015-2018

The Action Group developed a more structured framework where processors were engaged in the program with financial contributions centrally to fund a delivery team and website hosting.[5,6]

British Cattle Veterinary Association (BCVA) developed an online-training portal for veterinary surgeons wishing to partake in the NJMP with an accreditation process to develop a standardised approach to JD control. Over 800 vets have undertaken the training. Eighty-two per cent of the UK milk supply has now signed up to the NJMP which commits farmers to engage with a BCVA-accredited JD vet to conduct a risk assessment and create a written control plan with the selection of an appropriate strategy and related tasks to deliver effective JD prevention and control. The target for completion of phase 2, where every participating farm has a robust JD management plan, is October 2018. The programme is commercial and is driven by the processor with the farmer paying for planning, advice and controls. The success of the NJMP in the UK will be dependent upon financially viable and beneficial prevention and control programmes being introduced and maintained in participating farms: this requires flexibility and specificity.

WHAT CAN IRELAND LEARN FROM THE UK AND OTHER COUNTRIES?

Ireland has a low prevalence of JD with the pilot of 1,889 herds revealing 66% tested negative to a single round of testing. The risks of disease spread between and within herds will be different to the UK, where herds tend to be larger and often more intensive. A similar level of prevalence was demonstrated in Canada where retaining engagement with JD control proved challenging. The costs of repeated whole-herd surveillance using individual animal tests cannot be justified by the producer in low-prevalence herds. The key focus will have to centre on finding cost-effective surveillance strategies to determine disease status, and then adopting farm-specific surveillance and control programmes based on risk and current prevalence. JD prevalence is driven by risks and finding incentives and mechanisms to engage farmers to reduce the risk of entry and spread of JD are fundamental to long term control. Avoiding the classic trap of costly testing and certification will be key.

Given the right framework and approach. the Irish dairy industry is well positioned to control Johne's disease effectively.

REFERENCES

1. Hanks JD, Taylor NM, Kossaibati MA. Is targeted milk sampling an effective means of detecting Johne's disease in dairy herds? Cattle Practice 2013; 1-8
2. Geraghty T, ,Graham DA, Mullowney P, More S. A review of bovine Johne's disease control activities in 6 endemically infected countries. Prev Vet Med 2014; 116: 1-11
3. Nielsen SS. Danish control program for Danish paratuberculosis. Cattle Practice 2007; 15: 161-168
4. Orpin PG, Sibley RJ. Predict and prevent versus test and treat. Veterinary Record 2014; 174: 16 403-405
5. Orpin P, Sibley RJ, Throup S, Braddock A. The National Johne's Management Plan: progress and future developments. Cattle Practice 2017; 25(2): 106-110
6. Sibley RJ, Orpin PG. The National Johne's Management Plan: a national programme for the management of paratuberculosis in the UK dairy herd. 5th ParaTB Forum, 2016
7. Sibley RJ. Biosecurity in the dairy herd In Practice 2010; 32:7 274-280 doi:10.1136/inp.c3913

WEBSITES

CHeCs www.checs.co.uk/
Proceedings Dairy UK Johne's meeting www.dairyuk.org
Action Johne's www.actionjohnes.org.uk
Myhealthyherd www.myhealthyherd.com

Streptococcus uberis mastitis: management and prevention

Volker Krömker Prof Dr Dip ECBHM, Microbiology, University of Applied Sciences and Arts, Hannover, Germany, outlines how to tackle clinical mastitis

Improved management on modern dairy farms decreases the relevance of subclinical mastitis. Clinical mastitis is still a common and costly disease on dairy farms all over the world (IDF, 2005; Hogeveen et al, 2011). For several years, *Streptococcus uberis* has been the most important causative pathogen for clinical mastitis in many countries of the world.

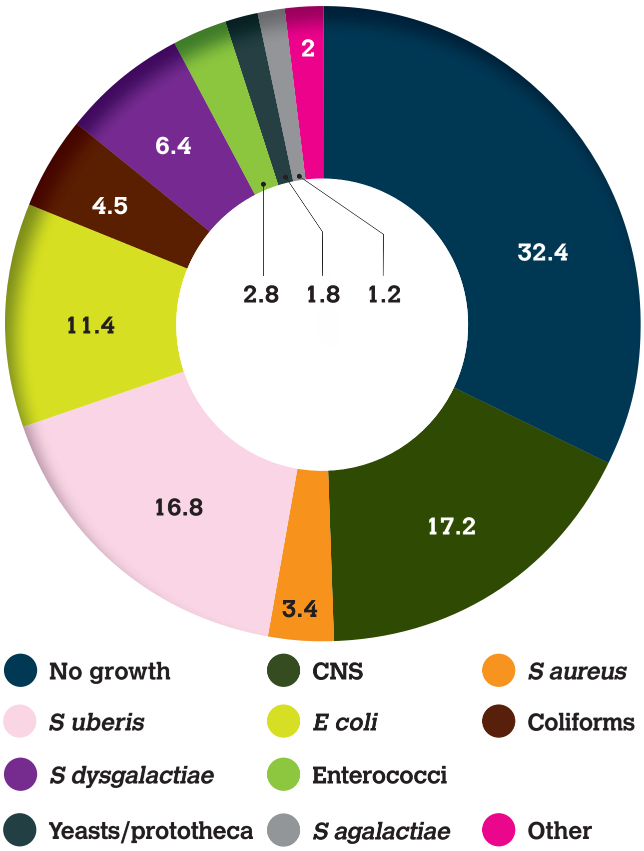

Figure 1: Clinical mastitis outcome 2013 (n = 14.233 – Hannover University mastitis laboratory, Germany).

CHARACTERISTICS OF *S UBERIS*

On blood-agar plates, *S uberis* grows at 30 to 37°C. Colonies have a diameter of 1mm to 2mm after an incubation period of 24-48 hours. Adding 0.1% aesculin to the medium enhances bacteria identification, as *S uberis*and enterococci hydrolyse aesculin to glucose and aesculetin. Examination under ultraviolet light confirms this reaction.

At present, many routine laboratories do not selectively differentiate *S uberis*. Due to the rising cost pressure of high-frequency analyses such as the microbiological investigation of quarter foremilk samples for mastitis pathogens, identification is often limited to aesculin-hydrolysing streptococci, failing to differentiate *S uberis* and enterococci or to identify aesculin-negative streptococci. Several virulence factors are known for *S uberis*. However, there are considerable differences in the exhibition of virulence factors between the various isolates. Biofilm formation is an important virulence factor that may cause recurrent or persistent mastitis by impairing the host immune defence and through the protection of antimicrobial substances. Nearly 100% of *S uberis* strains are able to produce biofilms *in vitro*. Moreover, the enzymes produced by *S uberis* seem to play a decisive role in the distribution of infections with this pathogen, which is able to impede the proper development of the mammary gland and to induce the formation of capsules in the tissue.

HABITAT

S uberis is a ubiquitous microorganism, which colonises animals as well as their environment. Environmental streptococci are responsible for about one third of all clinical mastitis cases. The pathogens enter the mammary gland via the teat canal. High pathogen levels in the animals' environment increase the infection rates. Zadoks et al. (2005) found that *S uberis* was present in 63% of environmental samples (ie. earth, vegetable material and bedding), in 23% of faecal samples and 4% of milk samples. During summer (grazing season), contamination rates in bovine faeces are higher than in other seasons. Straw and other organic bedding material enhance the growth of *S uberis*. If several cows in the same herd are infected, it is quite unlikely that all infections are caused by one identical *S uberis* strain. Udder infections, which are caused by one dominant *S uberis* strain, tend to persist on the farm for a longer period than udder infections caused by a multitude of strains. Most infections do not last a long time (16-46 days).

RISK FACTORS

The cases of clinical mastitis caused by *S uberis* are clearly associated with hygiene (cleanliness and dryness) in husbandry, feeding and machine milking. *S uberis* infections of the mammary gland can occur during the dry period (evaluation of the new infection rate in the dry period) and often develop an acute course in the following lactation. Straw and other organic-bedding materials promote the growth of *S uberis*.

RECURRENT MASTITIS

Udder quarters that have recovered from infection with *S uberis* or other microorganisms exhibit an elevated risk of reinfection. Recent research has shown that *S uberis*

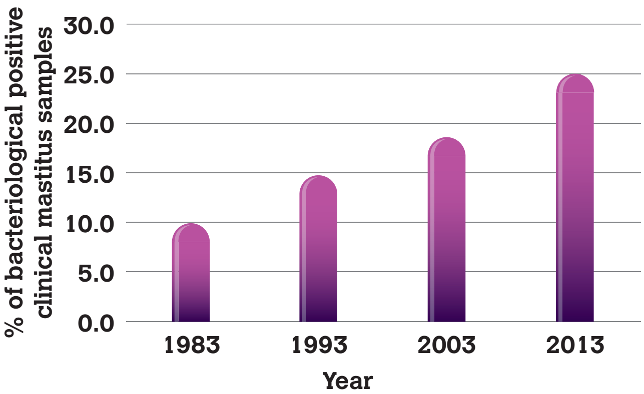

Figure 2: Relative importance of *S uberis* in bacteriologically positive clinical mastitis samples (23 herds – northwest Germany – n = 1,739 cases).

mastitis is often followed by recurrent *S uberis* mastitis cases. Strain-typing techniques have shown that most of these cases are new infections. Often misinterpreted as unsuccessful treatment, recurrent mastitis cases show that it is not the treatment that is the problem, but the fact that an infection increases the risk of new infections.

PREVENTION

HYGIENE IN HUSBANDRY CONDITIONS

An intramammary infection is initially preceded by contamination of the teats or the udder surface, whereby in indoor housing the risk of contamination during the inter-milking periods is determined by the design of the lying surfaces, the space per cow, the bedding material, the frequency of bedding addition, cleaning and disinfecting as well as the cows´ length of stay in the cubicles. The fact that the rate of infection with environmental mastitis is highest during the summer months accounts for increased bacterial counts in the bedding material. The indicator for the optimisation effort in hygiene of the resting area is the cleanliness of the teats. The objective should be for more than 90% of the animals to have only a few coarse dirt particles on the teats, which can be removed by simply wiping with a disposable towel or something similar. Feeding imbalances as well as fluctuations in the dry matter intake of the animals seem to be associated with the exacerbation of clinical *S uberis* mastitis.

MILKING

Machine milking can lead to the invasion of *S uberis* into the glands, which can be avoided by carefully cleaning the teats prior to milking. This can, but does not have to, be carried out by means of disinfecting measures before milking. A crucial point is that about 95% of the teats leave no or only slightly-yellowish residues on the disinfecting cloth with which they have had contact before the milking clusters are attached.

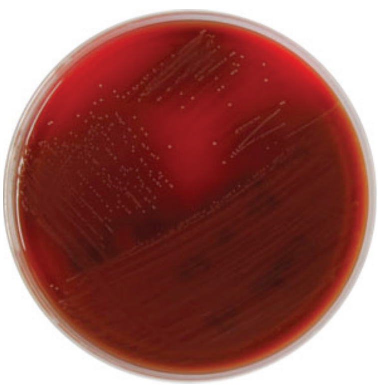

Figure 3: Growth of *S uberis* on blood-agar plate. Source: V Krömker.

THERAPY

Usually, *S uberis* is sensitive to penicillin preparations and other ß-lactams and the minimum inhibitory concentrations (MICs) of penicillin preparations and other ß-lactams are low for *S uberis*. Several studies show that an extension of the therapy period up to eight days is useful to increase the bacteriological cure rate (especially in young animals). The administration of oxytocin or performing additional milkings is not recommended, as these measures additionally increase the proliferation rate of *S uberis* in the mammary gland. The successful treatment of intramammary infections caused by *S uberis* is crucial in the dry period (antibiotic dry cow therapy and the prevention of such infections in the same period (teat sealer, hygienic husbandry conditions, control of hypocalcaemia, avoidance of loss of body mass during the dry period)) and lactation.

CONCLUSION

S uberis is one of the most important causative pathogens for clinical mastitis in many countries of the world, responsible for as many as one third of all clinical mastitis cases. *S uberis* is known for a set of virulence factors including biofilm formation. It is a ubiquitous microorganism, which colonises animals as well as their environment. The cases of clinical mastitis caused by *S uberis* are clearly associated with hygiene (cleanliness and dryness) in husbandry, feeding and machine milking. Extended antibiotic therapy is effective but is often followed by new infections, often with another *S uberis* strain. An effective vaccine, which primarily reduces the clinical exacerbation, would be of great benefit.

REFERENCES

Darwish SF, Asfour HAE. Investigation of biofilm forming ability in staphylococci causing bovine mastitis using phenotypic and genotypic assays. The Scientific World Journal 2013; 378492

Hogeveen H, Huijps K, Lam TJ. Economic aspects of mastitis: new developments. N Z Vet J 2011; 59(1):16-23. doi: 10.1080/00480169.2011.547165

IDF (2005): Economic Consequences of mastitis. Bulletin of the IDF No. 394/2005

Krömker V, Reinecke F, Paduch JH, Grabowski NT. Bovine Streptococcus uberis intramammary infections and mastitis. Clinical Microbiology 2014: open access 3; 4

Oliveira M, Bexiga R, Nunes SF et al. Biofilm-forming ability profiling of Staphylococcus aureus and Staphylococcus epidermidis mastitis isolates. Veterinary Microbiology 2006; 118: 133-140

Schönborn S, Wente N, Paduch JH, Krömker V. In vitro ability of mastitis causing pathogens to form biofilms. J Dairy Research 2017; 84(2): 198-201. doi: 10.1017/S0022029917000218

Zadoks RN, Tikofsky LL, Boor KJ. Ribotyping of Streptococcus uberis from a dairy's environment, bovine feces and milk. Vet Microbiol 2005; 109(3-4): 257-265