An Update on the Alberta Johne's Disease Initiative

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Take Home Messages

- Johne's disease programs have been implemented worldwide in all developed countries.
- Johne's disease programs based on testing and culling alone have not resulted in a sufficient decrease of prevalence.
- The Alberta Johne's Disease Initiative (AJDI) is a voluntary program of Alberta Milk, coordinated by the Faculty of Veterinary Medicine of the University of Calgary (UCVM)
- The overall objective of the AJDI is: "The Alberta dairy industry is aware of Johne's disease and implements best management practices to reduce its prevalence".
- The AJDI focuses on prevention of infection of calves.
- The Johne's Disease Risk Assessment, as part of the AJDI, is carried out by the herd veterinarian.
- The Johne's Disease Herd Status Program is one component of the AJDI.
- Research to improve the AJDI is important in the Initiative.

Johne's Disease

Johne's disease (JD) in cattle is an infectious chronic inflammation of the gut caused by *Mycobacterium avium* subspecies *paratuberculosis* (MAP). It is a major health problem in ruminants, resulting in intermittent diarrhoea, loss of body condition, and lower productivity. In the terminal phase, which most cows will not reach, animals die with a very poor body condition. Infected

cattle shed MAP in manure and milk in increasing quantities as the disease progresses. The disease is widespread in cattle populations in almost all countries with a cattle industry, and causes great economic losses, not only because of lower productivity, but even more by loss of future income due to early culling (McKenna et al., 2006a). The herd-level prevalence of MAP-infection is likely higher than 50% in most countries with a significant dairy industry (Barkema et al., 2010). It can be expected that JD will spread further if control measures are not implemented. The reasons for this are that as herds increase in size they are more likely to purchase animals, often from herds with unknown JD status. In Canada, the economic damage caused by JD was 10 years ago estimated at $50 per cow per year in infected herds (Chi et al., 2002), while Ott et al. (1999) estimated the disease to cost $100 US per animal on an infected farm or $250 million US per year to the cattle industry (Ott et al., 1999). Recent meta-analyses demonstrate that the association of MAP with Crohn's disease in humans is specific and cannot be denied (Abubakar et al., 2008; Feller et al., 2007), although a causal role has not yet been demonstrated. Neither has the transmission from cattle to humans been proven.

■ History of Johne's Disease Programs

Because of the economic losses caused by this disease, and in the last two decades, the possible association with Crohn's disease, worldwide many control programs for JD were developed during the last century. These programs were focused on infected herds. They were based on test and cull protocols of test-positive cows in combination with management adaptations (Benedictus, 1984; Collins, 1994; Rossiter et al., 1996; Kennedy, 2001). Tests used to identify infected cows were allergic tests, serological tests, direct detection of MAP by microscopy, and culture of MAP from fecal samples. Presently, fecal culture is considered to be the most sensitive and specific test to identify MAP-infection in the live animal (Kalis et al., 2002). However, because of the high cost of individual fecal culture, JD control programs most often use ELISAs to detect potentially infected animals.

Most control programs were not successful because management protocols were not carried out adequately, tests were not able to find all infected cows, and purchase of replacement animals caused new introductions in the herds (Benedictus, 1984; Collins, 2001). A complementary model study showed consistent application of preventive measures, not "test and cull" was crucial to control JD (Groenendaal et al., 2002). However, "test and cull" can support and speed up the process to eliminate the infection from a herd that also implements good management practices. Since there is no cure and there are no effective vaccines, control of JD is currently mainly based on herd management strategies to avoid initial infection of calves and restrict within farm and farm-to-farm transmission.

JD control programs have been implemented in most developed countries in the world. Building upon experiences with JD herd certification programs, voluntary certification programs started in 2002 in most states of the USA under the umbrella of the U.S. Voluntary Johne's Disease Herd Status Program for Cattle (Carter, 2011). The program that focuses on education, management and herd testing was revised in 2010 to decrease complexity and provide more flexibility in testing (Carter, 2011). In Canada, JD control initiatives focusing on risk assessment to prevent infection of calves with MAP including an element of herd testing differing between provinces, have recently been implemented in most provinces (McKenna et al., 2006b). In Australia, an ambitious certification program based on absorbed ELISA started in 1996 (Kennedy, 2011). Europe, Denmark and The Netherlands currently have a mandatory JD control program. Both programs focus on prevention of infection of calves and test cows using a milk antibody ELISA (Nielsen and Toft, 2011). Although JD control programs have been implemented in most developed countries, little experience with JD prevention and control programs is published worldwide. JD control programs are typically evaluated in a small number of herds (e.g. Collins et al., 2010; Pillars et al., 2011). Additionally, because of the biology of the disease, results of a JD control program can only be judged after at least a five-year period (Caldow and Gunn, 2001; Nielsen and Toft, 2011). Most of the current well-designed programs have not run that long.

■ Canadian Johne's Disease Initiative

The Canadian Johne's Disease Initiative (CJDI) was created to reduce the prevalence of JD in Canadian herds. The CJDI is a collaborative activity of industry, governments and veterinary schools, led by Dairy Farmers of Canada (DFC), the Canadian Cattlemen's Association (CCA) and the Canadian Animal Health Coalition (CAHC). The CJDI focuses on:

- Education and awareness - Develop and deliver coordinated educational information and communications about JD to farmers, veterinarians, government and other target audiences.
- Provincial coordination - Facilitate communications amongst provincial JD working groups, share JD awareness and extension messages, as well as recommend minimal program standards.
- Research - Scan international JD programs and research activities, as well as facilitate collaborations to enable priority Canadian research and cost-effective JD program delivery (text on CJDI copied from www.animalhealth.ca/Programs/Detail.aspx?id=24).

Nine of the ten Canadian provinces now have voluntary JD control programs in place. In each case, the programs were producer initiated and are managed by committees that include producer group, provincial government,

university, milk recording and veterinary association representatives. Although the testing components differ between the programs, they are essentially very similar and all focus on the prevention of MAP infection of dairy calves through a risk assessment and implementation of necessary best management practices.

Alberta Voluntary JD Herd Status Program

Alberta Agriculture and Rural Development (AARD) initiated the Alberta Voluntary Johne's Disease Herd Status Program in September 2001. The intent of AARD's program was to: a) categorize participating herds by risk for JD, b) reduce or stop the spread of JD, and c) communicate the level of risk of JD in participating herds to producers purchasing cattle. These are laudable goals and similar in essence to the AJDI objective. A small number of dairy and beef producers subsequently took part in this program, but as of May 2010 none of these producers had continued to meet the annual requirements for active participation.

The AARD program needed to be revised (based on the Herd Status program of the Canadian Johne's Disease Initiative) to deal with several shortcomings:

- It was heavily based on testing (insufficient attention to preventive management)
- A single MAP-positive resulted in a dramatic drop in an individual producer's status
- AARD ended funding for this program.

Why an Alberta Johne's Disease Initiative

Why do Alberta milk producers take the threat of JD seriously and implement this prevention and control initiative for disease?

- Because clinical signs of JD are just the "tip of the iceberg", with many producers not aware their herd is infected with MAP. As well, unless requesting specific information on JD when purchasing replacement cattle, a dairy farmer may unwittingly import MAP into his/her herd in a subclinically infected replacement animal purchased from another herd unaware of the presence of MAP-infected cattle.
- JD is a production-limiting disease, just like mastitis and lameness. Affected cattle produce less milk, take longer to become pregnant, and are worth less when culled. The economic impact of these production losses is dependent on the number of MAP-infected cows in the herd.

- In the later stages of infection, MAP-infected cows shed billions of MAP bacteria daily in their feces and pose a serious threat to replacement calves and the farm environment. MAP bacteria can survive in harsh environments for up to one year or longer.
- An additional benefit to implementing best management practices on farm is the impact they will also have on controlling other diseases, such as salmonellosis and viral calf scours that impact the health of calves and dairy replacements on many dairy farms.
- Internationally, animal health agencies are increasingly concerned about JD and some are, or are contemplating, banning importation of animals from exporting countries without a JD control program. In today's shrinking world, market access is increasingly focused on non-tariff animal health issues with the potential to threaten the importing country's livestock industry or human population.
- Although there is a definite association between MAP and Crohn's disease in humans, a cause-and-effect link has never been made. Research continues to clarify whether MAP causes Crohn's disease. Should a causative link be proven, an effective JD prevention and control initiative should position the Alberta dairy industry to be able to deflect a potential food safety concern.

Alberta Johne's Disease Initiative

Alberta Milk is proactively implementing the AJDI. The Alberta initiative is producer driven, built on the foundation of the national standards created as part of the Canadian Johne's Disease Initiative designed to meet the needs of Alberta's dairy industry, and is coordinated by the Faculty of Veterinary Medicine at the University of Calgary (UCVM).

The initiative consists of four elements:

- a) education,
- b) on-farm risk assessment for JD and development of a management plan to prevent/control JD,
- c) research to improve the initiative and monitor its success, and;
- d) JD Herd Status for those producers already participating in Alberta Agriculture and Rural Development's (AARD) JD Herd Status program, or those desiring to proceed beyond the new initiative's minimum standards.

The objective is to increase the awareness of JD in the Alberta dairy industry and encourage the implementation of best management practices (BMPs) that will reduce the risk of JD entering the herd, or spreading within the herd if MAP is already present in one or more animals.

The AJDI is implemented in three phases. Phase one, started in September 2010, is focusing on development of the initiative criteria and enhancing the awareness of veterinarians and milk producers of JD, and the importance of on farm BMPs. The purpose is to prevent introduction of MAP onto the farm, or to stop the spread of MAP should it already be present on the premises.

In Phase two, started in December 2010, the initiative was implemented and milk producers wishing to participate were enrolled. This phase will extend over a 24-month period. The ultimate goal is that at least 80 per cent of Alberta's milk producers will become engaged.

Phase three, started in December 2011, will implement the JD Herd Status portion of the AJDI. A number of Alberta dairy farms participated in the pre-existing AARD Voluntary JD Herd Status program over the past several years. Some herds withdrew from that program for a number of reasons. Those herds that participated in AARD's Voluntary JD Herd Status program will be offered an opportunity to be grandfathered into the new AJDI JD Herd Status component, subject to an assessment of the herd's present risk for JD on an individual herd basis.

■ JD Herd Status Program

The AJDI offers a voluntary herd status program option consisting of four levels for those cattle herds with a low prevalence of animals infected with MAP. Owners of herds with low prevalence of MAP may wish to advance beyond the initial control and management of JD and demonstrate the low prevalence of MAP in their herds for marketing or other purposes. A risk assessment must have been completed for the herd and the Johne's Disease Management Plan implemented.

Producers, who previously participated in a JD control program through AARD, may apply for "grandfathering" for the herd status program. Grandfathering would reward those herds that implemented efforts to control JD and have maintained some degree of herd testing. The AJDI Technical Committee (TC) will assess whether or not the herd in question qualifies for Level 1 or Level 2 status. Grandfathering to Levels 3 or 4 will only be considered in exceptional circumstances.

The following criteria are used to determine whether or not a herd will be grandfathered into the Herd Status program:

- Status achieved by the herd during participation in a previous JD control program,
- Amount and type of MAP testing conducted over the past five years, the accreditation or quality control status of the testing laboratory, and the results of all MAP testing,

- Disease history of the herd, including JD, for the past five years,
- History of potential herd exposure to MAP over the past five years,
- History of adding susceptible species to the herd over the past five years,
- Source(s) of herd additions over the past five years, and
- Herd biosecurity measures presently in place and the approximate year(s) in which they were implemented.

On-Farm Workshops

On-farm workshops have proven to be very successful in introducing producers to the AJDI. A host farm and an AJDI certified veterinarian team up together to lead a group of dairy producers through every corner of the dairy operation beginning with the baby calves and moving on through to the weaned calves, bred heifers, dry cows and milking herd. Participating producers are engaged in discussion about the JDRA, they are able to ask questions about the program and see first-hand what the risk assessment entails. The workshop interactions have allowed for clarification of the specific questions, sharing of personal producer situations and dialogue about the host farm situation and discussion about potential solutions based on the best management practices.

Research Program

The AJDI is based on current knowledge. However, after implementation of the program, research is needed to enhance it. Research efforts in the AJDI are driven by the wish to improve the program. Additionally, in the course of every prevention and control program, progress towards the goals of the program should be monitored. Too many JD control programs have been designed based on the assumption that the prevalence is relatively low without being based on a valid prevalence study.

AJDI's research program consists of the following elements:

- Herd prevalence of MAP in Alberta - Six environmental samples for MAP testing are randomly collected from enrolled Alberta dairy farms to provide a baseline of the prevalence of MAP in Alberta. The baseline will facilitate measuring improvement, and contribute to evaluating the initiative. Participating dairy farms will be re-sampled in the second and third years to monitor progress in preventing/controlling JD. Should a new validated MAP testing technology become available, it may be considered for use in the Initiative.
- Sampling locations – The proportion of positive environmental manure samples differs between the locations where the samples have been

collected. After an evaluation has been done, if necessary the sampling scheme of environmental samples will be changed.

- Best management practices - As part of the AJDI, UCVM is carrying out a graduate student project to evaluate the rate of adoption of BMPs agreed to in JDMPs, and an evaluation of their rate of success in prevention of new infections with MAP.
- Milk PCR – Bulk milk is routinely collected from all dairy farms for quality purposes. Cows can shed MAP in milk and also milk can be contaminated with MAP during the milking process. The intent of the project is to develop a PCR that can detect MAP in bulk milk which can be used in the AJDI.
- Survey - A producer survey will be conducted to evaluate current milk producer awareness and knowledge of JD, and their perspective(s) on controlling JD. This survey will be repeated annually in a representative randomly selected group of Alberta dairy farmers to determine the effect of the initiative on awareness and knowledge of JD and MAP.

Additionally, at UCVM a lot of research projects are carried out that will lead to improvement of the AJDI and other national and international JD prevention and control programs. Currently, 10 graduate students and 1 postdoctoral fellow are included in these projects. An important project is the one determining the effect of age and dose on susceptibility for MAP infection in calves. Recently, in a challenge experiment it was found that Holstein-Friesian calves can be infected through the nose with dust contaminated with MAP (Eisenberg et al., 2011).

Preliminary Results

As of December 31, 2011 201 (approx. 35%) Alberta dairy herds participated in the AJDI. The graph below describes the number of risk assessments conducted by different clinics in Alberta.

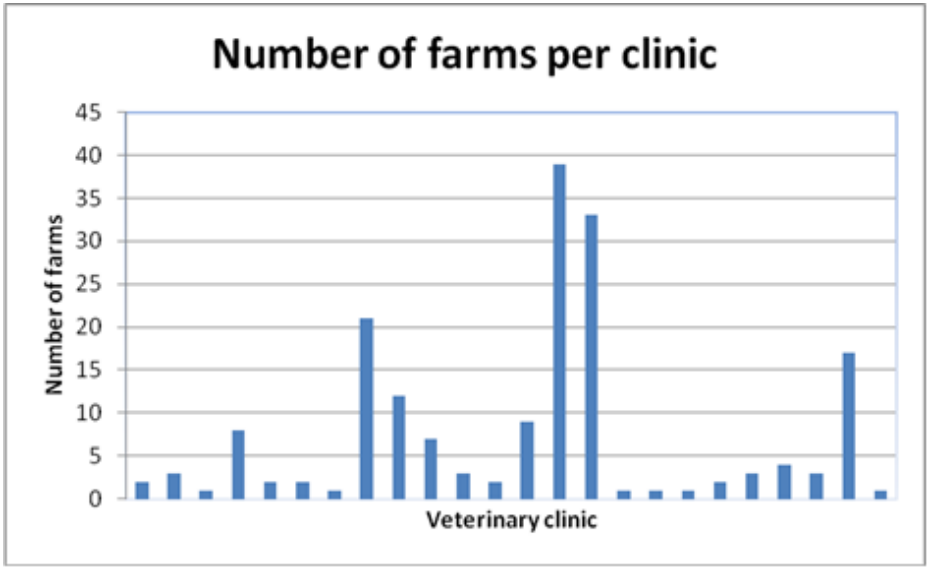

Figure 1. Number of dairy farms enrolled in the Alberta Johne's Disease Initiative per veterinary clinic (Dec. 31, 2011).

The unequal distribution of conducted risk assessments is due to differing clinic sizes. Large clinics with several veterinarians and a high number of dairy clients are responsible for most of the participation in the AJDI. Some smaller participating clinics have already enrolled all of their clients.

■ Environmental Samples

Environmental sample results from 177 farms are now available. 24% of the herds had at least one positive sample. Because all herds will be re-sampled in their second and third year of participation, it is expected that this percentage will increase significantly in those years. Table 1 summarizes the results.

Table 1. Culture results of the six environmental samples of 177 farms.

	Number	Percentage
Farms negative at all six samples	136	76
Farms with one positive sample	15	8
Farms with two positive samples	8	5
Farms with three positive samples	4	2
Farms with four positive samples	2	1
Farms with five positive samples	7	4
Farms with six positive samples	5	3

The wide spread of results and the high number of farms with only one or two positive environmental samples supports the theory that several environmental samples are needed to classify the status of a herd. It also leads to the conclusion that environmental samples collected at different locations have different sensitivities. Therefore, we analyzed the prevalences of positive environmental samples, taken at different sites on infected farms. Our preliminary findings are summarized in Table 2.

Table 2. Distribution of positive environmental samples over sampling locations.

Location	**% positive samples**
Manure concentration areas (alleys, scraper lines)	48
Manure storage areas (manure pits, piles, lagoons)	59
Cow concentration areas (sick cow, calving pens)	20

The relatively high percentage of positive samples collected at manure storage areas illustrates the long survival of MAP in the environment which enables us to use environmental samples to classify herds as infected or uninfected. The low percentage of positive samples collected in cow concentration areas is likely due to the fact that those pens are only used by a

small number of cows at the same time and therefore the odds are lower that manure from an infected cow is included in the sample.

Risk Assessments

Analyzing the risk assessments of farms enrolled to date (December 31, 2011), several common management practices (i.e. risk factors for introduction of spread of MAP) were identified in more than 50% of the farms:

- 63% of the farms had no restriction of any visitor access to any animal,
- 77% purchased animals without any precautions within the last five years,
- 55% of the producers fed calves with bulk tank milk or with pooled milk from several cows.

Most of Alberta dairy farmers do not take any precautions when they purchase animals or if they let visitors on the farm. This attitude contains a hazard for introduction of MAP and many other infectious diseases onto a dairy farm. Also, feeding of bulk tank milk or pooled milk from several cows increases the risk for calves getting infected with MAP.

After completing the Risk Assessment, the herd veterinarian and the farmer(s) discuss what management practices need to be changed. A maximum of three changes in management practices can be determined.

The most common suggestions were:

- Remove newborn calves immediately from the dam
- Consider JD herd status of seller farm before buying heifers
- Don't put sick cows into a maternity/calving pen
- Use clean boots when entering calf pen
- Consider feeding milk replacer to heifer calves

Summary

The first year of the AJDI has been a success on many fronts. The enrollment of over 200 Alberta dairy producers and participation of nearly all Alberta dairy veterinarians is certainly something to be proud of. The AJDI is well on its way to achieving its objective: "The Alberta dairy industry is aware of Johne's disease and implements best management practices to reduce its prevalence". Research findings and risk analyses will allow for a more clear understanding on the details of this complicated disease and certainly attract even more producers to enrol once having more clarification on things that can be done to prevent the spread and introduction of Johne's disease.

References

Abubakar, I., D. Myhill, S.H. Aliyu, and P.R. Hunter, PR. 2008. Detection of *Mycobacterium avium* subspecies *paratuberculosis* from patients with Crohn's disease using nucleic acid-based techniques: a systematic review and meta-analysis. Inflamm. Bowel Dis. 14:401-410.

Barkema, H.W., J.W. Hesselink, S.L.B. McKenna, G. Benedictus, and H. Groenendaal. 2010. Global prevalence and economics of infection with *Mycobacterium avium* subsp. *paratuberculosis* in ruminants. Chapter 2 in *Paratuberculosis: organism, disease, control*. Eds. M.A Behr and D.M. Collins. CAB International. ISBN 9781845936136, pp. 10-21.

Benedictus, G. 1984. Evaluation of organized control of bovine paratuberculosis in Friesland province, The Netherlands. Tijdschr. Diergeneeskd. 109, 905-916.

Caldow, G., and G.J. Gunn. 2001. Assessment of surveillance and control of Johne's disease in farm animals in Great Britain. www.defra.gov.uk/animalh/diseases/sac2.PDF.

Carter, M.A. 2011. State, federal, and industry efforts at paratuberculosis control. Vet. Clin. North Am. Food Anim. Pract. 27:637-645.

Chi, J., J.A. VanLeeuwen, A. Weersink, and G.P. Keefe. 2002. Direct production losses and treatment costs from bovine viral diarrhoea virus, bovine leukosis virus, *Mycobacterium avium* subspecies *paratuberculosis*, and *Neospora caninum*. Prev. Vet. Med. 55:137-153.

Collins, M.T. 1994. Clinical approach to control of bovine paratuberculosis. J. Am. Vet. Med. Ass. 204:208-210.

Collins, M.T. 2001. Prevention of paratuberculosis. Bull. Int. Dairy Fed. 364:46-53.

Collins, M.T., V. Eggleston, and E.J. Manning. 2010. Successful control of Johne's disease in nine dairy herds: results of a six-year field trial. J. Dairy Sci. 93:1638-1643.

Eisenberg, S.W., A.P. Koets, M. Nielen, D. Heederik, R. Mortier, J. De Buck, and K. Orsel. 2011. Intestinal infection following aerosol challenge of calves with *Mycobacterium avium* subspecies *paratuberculosis*. Vet. Res. 42:117.

Feller, M., K. Huwiler, R. Stephan, E. Altpeter, A. Shang, H. Furrer, G.E. Pfyffer, T. Jemmi, A. Baumgartner, and M. Egger. 2007. *Mycobacterium avium* subspecies *paratuberculosis* and Crohn's disease: a systematic review and meta-analysis. Lancet Infect. Dis. 7:607-613.

Groenendaal, H., M. Nielen, A.W. Jalvingh, S.H. Horst, D.T. Galligan, and J.W. Hesselink. 2002. A simulation of Johne's disease control. Prev. Vet. Med. 54, 225-245.

Kalis, C.H.J., H.W. Barkema, J.W. Hesselink, C. Van Maanen, and M.T. Collins. 2002. Evaluation of two absorbed ELISAs and a Complement Fixation Test as replacements for fecal culture in the detection of cows shedding *Mycobacterium avium* subspecies *paratuberculosis*. J. Vet. Diagn. Invest. 14:219-224.

Kennedy, D.J. 2001. Control of paratuberculosis. Bull. Int. Dairy Fed. 364:29-45.

Kennedy, D.J. 2011. International efforts at paratuberculosis control. North Am. Food Anim. Pract. 27:647-654.

McKenna, S.L.B., G.P. Keefe, A. Tiwari, J. VanLeeuwen, and H.W. Barkema. 2006a. Johne's disease in Canada part II: disease impacts, risk factors, and control programs for dairy producers. Can. Vet. J. 47:1089-1099.

McKenna, S.L.B., J.A. Vanleeuwen, H.W. Barkema, J.T. Jansen, G. Hauer, S.H. Hendrick, G. Cote, E.B. Salsberg, and R.E. Empringham. 2006b. Proposed Canadian voluntary national Johne's Disease prevention and control program. Can. Vet. J. 47:539-541.

Nielsen, S.S., and N. Toft. 2011. Effect of management practices on paratuberculosis prevalence in Danish dairy herds. J. Dairy Sci. 94:1849-1857.

Ott, S.L., S.J. Wells, and B.A. Wagner. 1999. Herd-level economic losses associated with Johne's disease on US dairy operations. Prev. Vet. Med. 40:179-192.

Pillars, R.D., D.L. Grooms, D.C. Gardiner, and J.B. Kaneene. 2011. Association between risk-assessment scores and individual-cow Johne's disease-test status over time on seven Michigan, USA dairy herds. Prev. Vet. Med. 98:10-18.

Rossiter, C.A., and W.S. Burhans. 1996. Farm-specific approach to paratuberculosis (Johne's disease) control. Vet. Clin. North Am., Food Anim. Pract. 12:383-415.