Prevention of Infectious Diseases: A Herd Approach to Preventing Johne's Disease and Leukosis

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Success in preventing infectious diseases requires a broad approach that considers all of the factors related to the onset, transmission and control of these diseases. Using this approach, a well designed prevention program encompasses all factors affecting resistance and all factors affecting exposure to the common bovine diseases. Programs based primarily on vaccines are most apt to fail and usually result in a poor rate of return on a significant investment. Effective programs are those based on a combination of sound management and sound medicine.

Factors Affecting Resistance

Nutrition

Attention to nutrition is of particular importance in disease prevention since the effectiveness of many other prevention practices depends on adequate nutritional status. For example, the immune response to vaccines may be suboptimal in animals deficient in protein, energy, selenium or other required nutrients. Similarly, the immune response may be suppressed if the ration is a source of stress, such as one that is too high in concentrate and too low in effective fiber.

The most common cause of low disease resistance in calves is a deficiency of colostral antibody. To achieve maximum protection from colostrum it is necessary to: (a) feed it as soon as possible after birth, (b) be certain that it is of high quality, and (c) ensure sufficient total intake in the first 24 hours of life. Negligence in any one of these areas can result in unsatisfactory antibody levels.

Vaccines

Selecting the most cost-effective vaccination program for any given herd is a challenge for the most experienced practitioner. Important considerations when deciding upon the use of any vaccine include:

1. Is the herd at high risk of being infected by the disease that the vaccine is designed to prevent?
2. Is the vaccine effective?
3. Is the vaccine safe or has it been shown to be related to the onset of other problems?
4. Is an outbreak of the disease likely to be more costly than the vaccine used to prevent it?

Unfortunately reliable answers to some or all of these questions are not always available and many decisions have to be based, at least in part, upon the practitioner's previous experience and observations with various vaccines, plus his/her assessment of the risk factors associated with each individual herd. Examples of high risk factors for an infectious disease include: the practice of purchasing herd replacements, high prevalence of the disease in the area, diagnosis of the disease on the farm in most previous years, and substantial numbers of animals in the most susceptible age group.

Vaccines are a preventative, not a cure. They will not produce satisfactory results if the decision to use them is delayed until the first case of disease occurs. By that time many or all of the animals may already be exposed and/or infected, and furthermore vaccinating such animals may only make them worse due to the added stress of the vacine. Similarly, if new animals will be entering the herd it is always best to vaccinate them at least a week prior to their assembly and movement rather than waiting until they arrive in the herd.

Finally, it must be kept in mind that vaccines cannot replace poor husbandry and that they should not be blamed for failing under such conditions. Too often vaccines are the first to b e criticized in the event of an outbreak, when in reality poor nutrition, ventilation and/or sanitation are the weaker links in the prevention program.

Stress

Many stressful events occur in today's modern management system that may well have an impact on resistance to disease. Although it is impossible to avoid all stresses, a well designed prevention program should minimize them and spread them out as much as possible. It is not surprising that the period surrounding calving is a common time for first calf heifers to develop respiratory disease when one considers the stresses they undergo at this time. Not only do they experience the stress of calving, but in addition at the same time, they are frequently moved from a pasture or manure pack to concrete and confinement housing, they are required to adjust to a milking parlor, they suddenly change from a high fiber, low energy diet to a low fiber, high energy diet, they begin to make consider-

able amounts of milk, and they are exposed to a new group of cows where they must learn to compete and find their place in the peck order. Although these stresses are mostly unavoidable, much can be done to reduce their impact by spreading them out as much as possible. For example, a well designed disease prevention program will avoid abrupt changes in the feeding program. Similarly, it will schedule foot trimming a month or more prior to freshening, rather than after calving.

Another factor deserving attention is the stress related to overcrowding, which is seen in many operations today, particularly in calf and heifer housing. The stress brought on by the pressures of confinement and crowding may have a much greater impact on resistance and on the incidence of disease than we appreciate.

Factors affecting rate of exposure

Two important husbandry concerns, ventilation and sanitation, are key factors in the prevention program since they, probably more than anything else, affect the rate of exposure to many pathogens. If either ventilation or sanitation is inadequate, prevention of respiratory disease is an uphill battle. Even cattle with optimal immunity cannot withstand infection when they are overwhelmed by excessive numbers of organisms due to insufficient air movement or damp and dirty conditions conducive to the buildup of bacteria.

Ventilation is the most critical factor affecting the incidence of respiratory disease on most farms. Although it is beyond the scope of this article to discuss ventilation in depth, it is an area that must be addressed thoroughly when designing a disease prevention program. This is especially true as cattle numbers continue to increase on many farms such that crowded conditions are common, particularly among the calves and heifers. Furthermore, these same animals are often housed in older or remodeled facilities that can be very difficult to ventilate. To remedy the ventilation deficiencies in these facilities usually requires more than simply adding exhaust fans. The best approach, by far, is to utilize the services of a ventilation consultant who has both the expertise and equipment to properly evaluate your present ventialtion system and also the ability to determine additional ventilation needs and a system that will meet them.

Attention to sanitation must begin in the calving area and continue throughout an animal's life. If calves are born into a dirty environment or if they are transferred to pens or hutches that are damp and contaminated, expect trouble. Where hutches are blamed for calf diseases they are typically on wet, poorly drained sod and are often poorly constructed and heavily contaminated with manure from previous calves. Hutches need to be on crushed stone or similar material to provide adequate drainage and dryness. In addition they must be constructed in a way that allows for easy moving, cleaning and disinfecting, since each of these practices is necessary before a new calf is placed in a hutch.

A third important factor affecting the rate of exposure is the presence of sick cattle within the herd. Once one or more clinical cases of disease develop, the exposure rate to infectious organisms multiplies dramatically. Again, this is especially true in crowded conditions or in free stalls or pens where there is increased opportunity for contact or aerosol transmission. Thus it is critical that clinically ill animals be recognized for their ability to rapidly spread disease and be isolated immediately from the remainder of the herd. Unfortunately increased shedding of disease causing organisms often occurs before clinical illness is apparent. Therefore in the presence of a disease outbreak it is wise to check temperatures of seemingly healthy herdmates so that new cases can be identified and isolated as soon as possible.

In a large proportion of disease outbreaks there is a history of the illness first appearing in new animals that have recently entered the herd, especially if they have come via a sales facility where they were exposed to other cattle. In retrospect, this should not be surprising since these animals have violated nearly all of the rules of basic disease prevention. They have been heavily stressed due to moving, adapting to a new environment, competing with new animals, and adjusting to a new nutrition program, while at the same time they have been exposed to a wide variety and high numbers of pathogens. Consequently, replacements should not be purchased through a sales arena. If outside replacements must be brought into the herd they should (a) be vaccinated prior to moving, (b) be moved well in advance of calving (c) come directly from the herd of origin, (d) be isolated from the herd upon arrival, and (e) introduced into the herd under ideal environmental conditions, such as when cattle are on pasture.

In summary, success in preventing disease requires an ongoing effort to incorporate both management and medicine into a program that maximizes resistance and minimizes exposure to the common pathogens.

An Eradication and Prevention Program for Johne's Disease

Johne's Disease (Paratuberculosis) is a difficult disease to eradicate and prevent; however if the above approach to designing a program is followed it appears possible to eliminate this disease from infecting herds. Since this disease is not curable with current therapeutics, the program must be based upon identifying and culling or isolating infected animals, and on management to prevent both vertical and horizontal transmission from potentially infected animals within the herd. Thus an understanding of the diagnostic tests and pathogenesis of the disease is necessary to develop an effective program.

Johne's disease is a chronic infection of the intestinal tract of cattle, goats, sheep and other ruminants. The syndrome covers a spectrum of illness ranging from inapparent infection, to a profuse, chronic diarrhea leading to emaciation and ultimately, death of the animal. The bacterial agent causing this disease, *Mycobacterium paratuberculosis,* is thought to be spread most commonly by ingestion of food or water contaminated with feces containing the organism, but may possibly be transmitted to the fetus *in utero,* or to the neonate in colostrum or milk from an infected cow. Some individuals shed large numbers of organisms into the environment whereas other infected animals may only shed the organism intermittently without showing signs of clinical disease. Animals less than one year old are most susceptible to primary infection while mature animals appear to be more resistant.

M. paratuberculosis is naturally resistant to a wide variety of antibiotics (including those used to treat human mycobacterioses), and can survive for long periods of time (up to 1 year) in soil, stagnant water or feces under ideal environmental conditions. In the laboratory the organism grows very slowly, and infected fecal samples must be incubated for at least 12 weeks before growth is evident.

The following methods are *now* available for the laboratory diagnosis of paratuberculosis, however, they all have limitations that render them less than ideal.

1. *Examination of feces.* Fecal culture is the most widely used diagnostic method. Cultures must be incubated and examined for at least 12 weeks before being considered negative. In spite of this long incubation time, culture has the advantage of not giving false positive results. Microscopic examination of fecal smears has also been used in some settings to diagnose Johne's disease but it has the disadvantage that *M. paratuberculosis* cannot be distinguished from the other acid-fast mycobacteria that may occur in feces as a result of environmental exposure. Both fecal examination methods suffer from an inability to detect organisms present in low numbers in animals that are carriers or intermittent shedders, or in the early stages of infection.
2. *Serologic tests.* A number of blood tests have been developed for the diagnosis of Johne's Disease. The complement fixation (CF) test is the one most widely used for this purpose. Unfortunately, this test is not sensitive enough to routinely detect animals in the subclinical stages of the infection. When clinical signs are present, a CF titer of 32 or greater is usually indicative of Johne's disease.
   AGID and ELISA tests are now commercailly available. The AGID test appears to be a useful aid in confirming a clinical diagnosis but will miss a number of subclinically infected animals which are proven to be culture positive. The utility of the commercial ELISA has yet to be proven. In the presence of clinical signs, the results of the CF and CGID tests, taken together, are quite useful. However, since many subclinically infected animals do not produce adequate antibodies for detection by CF or AGID, inclusion of a fecal sample for culture, along with serum is helpful in making a laboratory diagnosis.
3. *Microscopic examination of tissues.* Visualization of the organism in lesions in the intestinal lining or adjacent lymph nodes is one of the best diagnostic methods. However since surgery is necessary to obtain a proper specimen from a living animal, this method of laboratory diagnosis is used primarily on animals presented for post mortem examination or on very valuable animals where a biopsy may be taken surgically.
4. *Skin tests.* A skin test using an antigen called "johnin," derived from killed *M. paratuberculosis* is often used to measure a possible hypersensitivity reaction in an individual animal. This test is plagued by an inherent cross reactivity of johnin with other bacteria, including environmental mycobacteria. A slightly better, but still fairly inaccurate test employs intravenous injection of johnin followed by monitoring the animal for 24 hours for a rise in temperature. This is obviously a very time consuming procedure and the lack of adequate sensitivity or specificity of this test precludes its use in routine diagnosis.

Eradication Procedures

When designing an eradication program to eliminate paratuberculosis from a herd, the following pathogenesis regarding this disease must be considered:

1. *Mycobacterium paratuberculosis* is shed in the feces and may also be shed in the milk and colostrum of infected animals.
2. Shedding by infected animals is usually greatest at a time of heavy stress, such as calving.
3. The route of infection is usually fecal-oral.
4. Most infections occur at birth, or shortly thereafter, when the calf ingests infected feces from the dam as it attempts to nurse, or when it consumes infected milk or colostrum.
5. Based on research in Ohio and Pennsylvania, 5%-25% of the calves born to paratuberculosis infected dams can be infected *in utero,* and thus may be born with the disease. Transmission is more likely as the dam approaches the clinical stage of the disease.

An outline of the eradication program recommended in the New York State certification program is included at the end of this section. The management components of the program are designed to prevent vertical transfer of infection to the newborn calf by removing it from its dam

immediately after birth, and also to prevent horizontal transmission by reducing exposure through strict sanitation procedures and housing practices that minimize contact between calves and older animals.

The fecal culture testing portion of the program is designed to further decrease horizontal transfer by indentifying infected animals before they develop clinical signs, so that they can be removed from the herd before they become heavy shedders of the paratuberculosis organism. Unfortunately, although most infections occur prior to, or around the time of birth, these same infections are usually not diagnosed by fecal culture until such animals are two or more years old. Since intermittent, or low level shedding of the organism is therefore possible for a long time prior to diagnosis, it can be difficult to prevent horizontal spread of the disease in highly infected herds.

Eradication is also made difficult by the fact that Johne's Disease is usually not diagnosed until cattle have had one or more calves. Since *in utero* transmission can be significant, any calves born to these infected cows must be considered high risk animals that stand a good chance of being infected. Consequently, it is recommended in the New York eradication program that all offspring in the herd from infected cows be slaughtered before they develop the potential to spread the disease.

In light of the pathogenesis of Johne's Disease and the above limitations using available tests, complete eradication of the disease can take a long time, especially if the infection is already well established in the herd. However, by emphasizing the importance of management, as well as regular fecal culturing, we are able to make progress in most of our program herds. One must keep in mind that since most positive animals are infected for two or more years before they are diagnosed, the rate of newly diagnosed infections isn't likely to decrease until a herd is on a management and testing program for at least two years.

Research efforts currently underway at Cornell and other laboratories in the U.S. and worldwide are trying to develop direct detection and serologic tests that will have sufficient sensitivity and specificity to accurately detect infections before fecal shedding of the organism occurs. Until such tests are available, horizontal transmission, particularly in heavily infected herds, will be difficult to control and eradication will be slow. In herds with minimal infection, however, where fecal testing is carried out on a frequent and regular basis, and where management practices are emphasized and strictly adhered to, it appears that eradication is possible with the knowledge and tools at hand. Therefore, it is wise for more farmers to test their cattle for this disease, so that herds with a low level of infection have a better chance of eradicating it, while herds that are entirely negative are identified as important sources of "Johne's Disease-Free" replacements.

New York State Paratuberculosis Program

1. All animals shedding *M. paratuberculosis* (fecal culture positive) and all animals which develop clinical disease, as well as their latest offspring, should be sent to slaughter or segregated to separate facilities. **Under the NYS program, fecal culture positive animals will be quarantined to slaughter by the locally assigned state veterinarian. This will not affect the movement of healthy animals from the herd.**
2. Isolate animals with signs consistent with Johne's disease (persistent diarrhea or weight loss) until cause is determined.
3. Herd additions should only be made from herds unlikely to be infected with paratuberculosis or from paratuberculosis-tested-negative herds. All additions should be tested by fecal culture immediately upon entering the herd.
4. Stop transmission of the infection to young animals. This requires evaluating and modifying management practices to eliminate any opportunities for young stock to have any direct contact with, or probably more importantly, to accidentally ingest manure from adult cows.
    a. Remove calves from dams immediately after parturition and place in clean, uncontaminated quarters. Do not allow natural nursing.
    b. Feeding each calf the first colostrum from its dam if she is an older cow in good health. If the dam is a first calf heifer feed her calf colostrum that has been previously obtained and frozen from older, culture-negative cows. After colostrum, feed milk only from older healthy cows or feed milk replacer.
    c. Protect all feeds and feeding areas from contamination with manure by keeping animals, as well as people with dirty boots, out of and away from mangers, bunks and feeding alleys.
    d. Do not feed young cattle from feed and water facilities used for adult cattle and do not feed them leftover feed from the adult herd. If feed or feed areas can be contaminated with manure this could provide a regular opportunity for young stock to ingest the bacteria directly.
    e. Raise replacement calves and heifers in areas or facilities that are or can be, physically separated from the adult cows or their environment. Ideally, heifers should not have contact with the mature herd, including dry cows, until they are two years of age or ready to enter the herd. If totally separate facilities are not possible, full or partial solid walls can be added to separate areas to be used ONLY for young stock in order to prevent contamination by manure from adults.
    f. Clean and disinfect barns and equipment to re-

move fecal contamination.

g. Do not pasture cattle and do not harvest hay on land where manure has recently been spread.

h. Fence off or drain stagnant water.

5. Since the rate of shedding of *M. paratuberculosis* from infected cows can be related to the level of stress, attempt to minimize stress through sound nutrition and management.
6. Artificial insemination with semen from Johne's negative bulls should be used in the herd.
7. While vaccination may reduce the prevalence of clinical Johne's Disease, vaccines alone will not eliminate the paratuberculosis organism from infected animals nor will they prevent the organism from spreading to other noninfected animals.

An Eradication and Prevention Program for Leukosis

Since the bovine leukosis virus (BLV) resides in the lymphocyte, Leukosis is truly representative of a bloodborne disease. Therefore the pathogenesis and approach to its eradication and prevention are quite different from Johne' Disease.

Review

1. BLV infection is common in many herds even though the incidence of clinical disease, as manifested by tumors (lymphosarcoma) is relatively low in most herds.
2. BLV resides primarily in blood lymphocytes where circulating antibodies are unable to neutralize the virus particles. Consequently, once an animal becomes infected it is infected for life. In addition, it will always be a potential source of BLV infection and it will continue to test BLV positive on subsequent diagnostic tests.
3. The virus can be spread by both natural and iatrogenic vectors that transfer blood (lymphocytes) from infected to noninfected animals.
4. Some calves born to BLV infected dams (3-20%) will aready have been infected *in utero.*
5. Currently there are no vaccines that prevent this disease and no antibiotics that eliminate it.

Eradication Procedures

The leukosis eradication and prevention program recommended in New York State, as outlined at the end of this document, is designed with the above review facts in mind; thus it consists of a testing protocol that identifies positive animals, and a management protocol that defines specific management practices to prevent the transfer of lymphocytes from positive to negative animals.

One of the most critical, and yet easily controlled management practices in the program is the requirement that individual needles must be used for all injections (including vaccinations). Other management practices where special steps are necessary to avoid blood transfer or contamination of the environment with blood include, dehorning (electric dehorning is recommended), ear tagging, tattooing and castrating. Instruments used for these procedures must be disinfected between animals and care must be taken to ensure that animals do not come in contact until all bleeding has stopped.

The amount of BLV infection that occurs when calves consume colostrum from BLV positive cows appears to be quite small. Even though colostrum may contain the leukosis virus, it will usually contain sufficient antibodies provided it is of high quality, to neutralize this virus, thereby rendering the colostrum relatively safe for calves. Furthermore, these antibodies will serve as protection against subsequent infection during the first months of life should the animal be exposed to the virus through infected milk or some other vector. On the other hand, **low quality** colostrum (sometimes produced by first calf heifers or stressed cows) may **not** contain sufficient antibody to neutralize the virus and such colostrum could be infectious. Therefore, if colostrum is fed from BLV positive cows, it should first be evaluated with a colostrometer, and then only the highest quality colostrum should be fed. The other alternative is to feed only colostrum from known negative cows. This avoids colostral mediated infection but has the advantage of failing to provide antibodies that can be protective in the event of subsequent exposure to BLV in the first few months of life.

Since milk produced beyond the colostral stage contains many lymphocytes (somatic cells) but no antibody, it may be infectious for calves if fed from BLV positive cows. Consequently, feeding whole milk from positive cows should be avoided unless it is first pasteurized. Similarly, bloody milk should not be fed.

When a herd contains one or only a few BLV positive cows, the owner usually elects to sell these cows immediately in order to become leukosis-free. When a high percentage of the herd is BLV positive, however, the most logical and practical approach to eradication appears to be through the development of a BLV negative heifer herd raised apart from the milking herd. Heifer management usually allows more flexibility than milking cow management, thus it is more feasible to develop a negative group of heifers than to either separate positive and negative animals in the milking herd or to sell all of the positives in order to eliminate the disease. By having an ample source of negative replacement heifers, a farmer can, through normal culling practices, gradually replace all of his BLV positive cows with negative heifers. Since BLV does not spread readily within the herd under proper management, this approach allows the farmer to eventually rid the disease from the herd. Evidence in support of this approach

is seen in the herds participating in the New York certification program. Depending on their culling rate, most of the herds that raise negative replacements are making rapid progress toward eliminating the disease and becoming "certified-free". Their accomplishments demonstrate that even where BLV infection prevalence is high, eradication is quite possible.

New York State Bovine Leukosis Program

1. All animals older than 6 months will be tested every 4-6 months by a USDA-approved test.
2. Herd additions must be BLV negative animals.
3. Sterile, disposable needles must be used **only on one animal** and then discarded immediately.
4. A different disposable obstetrical sleeve must be used in palpation of each individual cow.
5. Routine methods of insect control must be employed.
6. Animal handling procedures should be established such that BLV negative animals are processed first.
7. Calves from seropositive cows should be removed after one day of age and reared in single isolated hutches away from the BLV negative animals until such time as it has been determined that the calf is also seronegative.
8. Blood contaminated instruments (dehorning, castrating, etc.) must be disinfected between animals.
9. Artificial insemination should be used in the herd.
10. Separate heat check and maternity pens for BLV positive and negative cattle should be maintained.