Developing Biosecurity Programs for Dairy Herds

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Take Home Message

- A biosecurity program identifies health risks that each herd faces and then identifies the most important, practical, and cost effective actions that can be taken to minimize those risks in that herd.
- Steps to develop a biosecurity program include:
  - Complete a risk assessment of to identify infectious diseases of particular concern for the herd.
  - Develop a plan to prevent introducing new diseases into the herd.
  - Develop a plan to minimize the spread of diseases within the herd.
  - Implement the plan.
  - Monitor the results (and revise as needed).

Introduction

Infectious disease is an important cause of economic loss in commercial dairy herds. While the losses from acute herd outbreaks or individual cow clinical cases may be quite obvious and dramatic, greater economic losses often arise from either chronic or subclinical infections. These losses are typically more subtle, but no less real, affecting health, productivity, and profitability over a longer period of time. Biosecurity describes a program for the control of infectious disease, both between and within herds.

Every known disease cannot be included in a herd biosecurity program due to practical reasons. It also is not possible to describe one biosecurity program as being appropriate for every herd situation. However, an excellent starting point is to consider the biosecurity aspects for the infectious diseases that are

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known to commonly occur in a given region of the world. This paper will discuss the basic principles of developing a biosecurity program including the initial completion of a risk assessment, developing a plan to prevent introduction of new diseases into the herd, and developing a plan to minimize the spread of diseases already present within the herd. This paper will also present some basic information on methods of transmission, methods for testing, and potential methods for prevention and control for a number of significant infectious diseases that are known to affect dairy cattle in North America (Table 1 - at end of paper). Reviewing this list can serve as a starting point for a veterinarian when they are working with clients in developing a herd biosecurity program for North American dairy cattle.

Major Infectious Diseases of Dairy Cattle in North America:

- Bovine viral diarrhea virus (BVDV)
- Johne's disease (*Mycobacterium paratuberculosis*)
- Contagious mastitis (*Staph aureus, Strep. Agalactiae*
- IBR, BRSV and PI_3 viruses
- Enteric pathogenic *E. coli*, rotavirus and coronavirus
- Salmonellosis
- *Mycoplasma bovis*
- Hairy heel warts
- Leptospirosis
- Neospora caninum
- Bovine leukosis virus (BLV)

Basic Principles for Developing a Biosecurity Plan

After a risk assessment is performed to identify the key pathogens of concern, a plan must be developed for their control. Infectious diseases of cattle result from the interaction between the animal, the environment, and the infectious agent. The producer must consider the most practical and cost-effective ways to manipulate any or all of these 3 components in order to develop an effective biosecurity program. The basic principles, which need to be addressed in any biosecurity plan, include:

- Risk Assessment
- Prevent introduction of new diseases into the herd:
  - Know the herd of origin
  - Test purchased cattle for infectious disease status
  - Method of introduction and quarantine period
  - Control traffic onto the farm

- Minimize the spread of disease within the herd:
  - Test to identify carrier animals => treat, manage or cull
  - Control vectors and fomites
  - Strategic vaccination to increase immunity against specific diseases
  - Good management & nutrition to enhance general immunity
  - Housing, sanitation, and hygiene to prevent exposure/transmission of disease

Risk Assessment

Veterinarians and producers should perform a risk assessment in order to decide which diseases need to be addressed, and the most effective and cost-efficient way to do this.

Identify the goals of the dairy operation: This relates to the products sold now and in the future (milk, dairy beef, calves heifers, milk cows, embryos, semen) and how long the dairy plans to operate.

Identify and prioritize the key hazards on each operation in relation to the goals: This involves identifying the infectious diseases most likely to threaten the operation.

Evaluate key methods of transmission of important pathogens (e.g. understand incubation periods, duration of clinical disease, duration of shedding, survival or growth in the environment) (Outlined in Table 2 for most major pathogens).

Evaluate potential methods of pathogen control and changes necessary to implement an effective biosecurity program. The benefits of controlling risks must be weighed against the costs and managerial difficulty of such a program. Producers may want to begin by targeting the two or three of the most important management areas. Once management of these areas is being done well, the program could then be expanded if necessary.

Once the risk assessment is performed, the producer, veterinarian and management team can plan and then implement a preventive biosecurity program. It is important that the final plan be documented and communicated to all members of the management team. After its implementation, a monitoring or surveillance program must be put into place to evaluate the plan's effectiveness and to identify new or emerging diseases. This requires accurate diagnosis of diseases and consistent recording of disease occurrences. In the ideal system, any animal that dies on the dairy would undergo a necropsy to confirm the cause of death. The biosecurity program should be reviewed at least annually, if not every 6 months to begin with, and expanded or modified as needed.

Prevent Introduction of New Diseases

In an ideal world, introduction of infectious diseases could be best avoided by maintaining a '**closed herd**'. This would prevent purchasing, boarding, or loaning calves, cows or bulls, sharing pastures or fence lines with cattle from other farms, returning animals to the herd after shows, and transporting cattle in someone else's vehicle. While a truly 'closed herd' may not be practical or possible in today's climate of commercial dairies, dairymen should understand that unknown sources equate to unknown risk levels for introduction of infectious diseases. If one is "lucky" you may never have a major disease outbreak when purchasing from unknown sources. However, the authors believe that it is advisable to always consider the worst-case scenario concerning infectious disease when purchasing animals from unknown sources. If you play with fire, it is likely at some point you will get burned. If new animals are to be introduced to the herd, steps can be taken to minimize the risks of introducing new diseases:

If Possible, Know the Herd of Origin

- The buyer's veterinarian and the seller's veterinarian should discuss the current (actual, not hypothetical) herd vaccination program, general herd health status, and specific disease histories.
- Somatic cell count data, bulk tank bacteria counts, clinical mastitis records, and bulk tank or individual mastitis culture results should be reviewed for the source herd.
- Examine the animal's somatic cell count (SCC) history, clinical mastitis records, and culture results. Examine and palpate each cow's udder and teat ends.
- Know the vaccination history of the individual animal you are considering purchasing
- Avoid purchasing animals from unknown sources or that have been mixed with many other cattle before sale.
- If possible, buy heifers rather than mature cows. Because they aren't milking yet, they will be easier to quarantine and are less likely to have contagious mastitis.
- If practical and economically feasible, purchase open heifers so that they can be tested and properly vaccinated prior to breeding.
- If purchasing heifers from a heifer grower, know their biosecurity, vaccination, and testing program.

Decide Whether Or Not to Test All Purchased Cattle for Infectious Disease Status

- When deciding whether or not to test for a specific disease, one must

consider such factors as the accuracy of the diagnostic test being used, how the disease is transmitted, and the financial cost of testing versus the potential risk and cost of introducing a new disease. Use your veterinarian to help you make this decision. While there is no universal consensus on which diseases to test for, some worth discussing include:

- Bovine Viral Diarrhea Virus (BVDV): persistent infection (PI)
- *Neospora caninum*
- Contagious mastitis caused by *Staphylococcus aureus*, *Streptococcus agalactiae* and *Mycoplasma bovis*
- *Mycobacterium avium* subsp. *paratuberculosis* (Johne's disease)
- Bovine Leukosis Virus (optional)

Because it takes 3-4 weeks to return some test results, samples should be collected and submitted upon arrival of the animal into the quarantine area. Alternatively, purchasers may arrange to test animals while they are still on the seller's property, prior to transport.

Johne's Disease example. Due to the dynamics of some diseases and the imperfection of some diagnostic tests, it may not be possible to accurately identify infection in every individual animal by testing upon arrival at the dairy. For example, there is less than a 15-25% chance that an ELISA test will detect infection with *Mycobacterium paratuberculosis* (Johne's disease) in a 24-month old heifer that is still in the early subclinical stages (e.g. stage 1) of the disease. Under these circumstances, we can still dramatically lower the risk of introducing a Johne's-infected animal by purchasing heifers from herds that have previously tested for Johne's disease and are known to be low risk herds (low prevalence or negative) (herd infection status can often be determined more accurately than the infection status of any single individual) (refer to Figure 1).

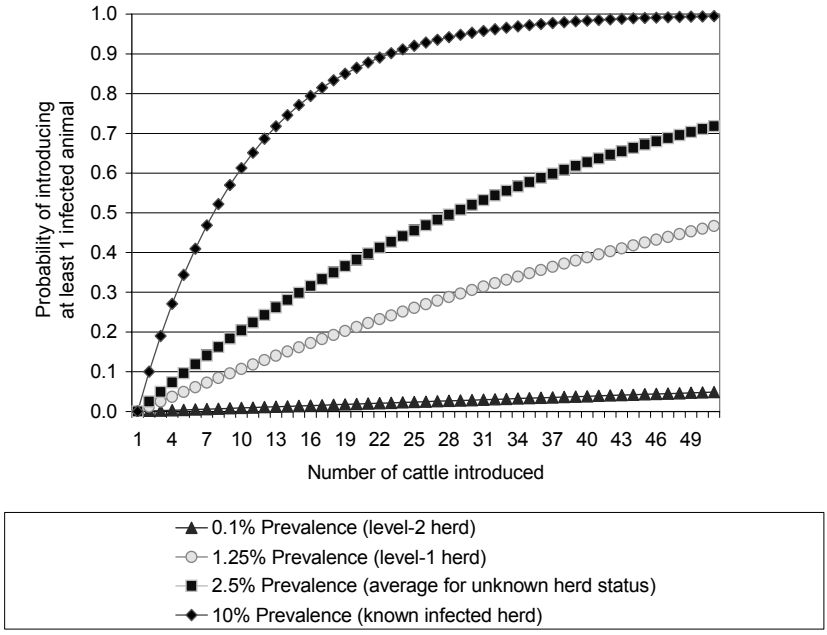

Figure 1: Probability of Introducing Johne's Disease When Purchasing Cattle from Source Herds with Different Prevalences of Johne's Infection (Adapted: Wells, 1999)

Method of Introducing New Arrivals:

- Animals should be transported in the buyer's vehicle, which should be cleaned both before and after transporting newly purchased cattle. If someone else's vehicle is being used, be certain it is cleaned and disinfected before and after use.
- New arrivals should be housed in a designated quarantine area for 30 days before allowing contact with resident cattle. Quarantined animals should not share the same air space, waterers or feeders, or have nose-to-nose contact with resident cattle.
- Vaccinate animals while they are in quarantine to make sure they are integrated into the farm's vaccination program (see Table 1: example of basic vaccine schedule).
- Collect the necessary samples to test for infectious disease status (see 2.b above). Purchased cattle should use a medicated footbath upon arrival and should have their feet examined and trimmed by a professional trimmer. It is important that hoof-trimming equipment be disinfected between each cow.

- Observe quarantined animal's attitude, dry matter intake, and temperature regularly. Prevent the spread of contagious mastitis by using proper milking hygiene, sanitation of milking equipment, and milking the new cattle last in the milking process.

The quarantine period serves to protect both new and resident populations of cattle: The resident cattle are protected from exposure to new infections until the quarantined new arrivals can be properly tested, vaccinated, and monitored for signs of clinical disease. Alternately, the new arrivals are protected from exposure to diseases present in the resident herd for a period until they can be properly vaccinated and have increased their resistance to those diseases. While the quarantine period may be possible for far-off heifers, it may difficult to apply these measures to lactating cows. In this situation the buyer may arrange to have animals tested and vaccinated while they are still on the seller's property.

Control Traffic onto the Farm

Infectious diseases can be introduced to the farm via fomites such as transport vehicles, rendering vehicles, and visitors' boots and clothing. Vehicles should be cleaned before arriving on the farm and should have limited access to one area of the farm. 'Off-farm' peoples' access should be restricted from parlors, barns, and other facilities. Visitors need to be provided with clean boots and coveralls.

■ Minimize Spread of Diseases Already Present On the Farm

Test To Identify Carrier Animals Already In the Herd

The goal here is to identify and then treat or remove infected animals that may serve as reservoirs or sources of infection for other animals in the herd. The diseases to consider testing for are the same as for new arrivals (see 2.b). Once identified as a carrier or infected animal, the producer and veterinarian can decide on the appropriate action: treat, isolate, or cull. Depending on the disease in question some animals may be treated and cured (e.g. *Strep. agalactiae* mastitis). Depending on the farm's cash flow position, immediate culling may not be wise or necessary. With many diseases, some animals may continue to be very productive for some time to come (e.g. *Staph. aureus* mastitis or Johne's positive cows). In the case of a Johne's test-positive cow, moderate-to-high fecal shedders should be culled at the earliest opportunity to prevent further contamination of the environment. However, if it is not practical to cull, then non-shedders or low-shedders should be managed to limit exposure to other cows. Producers should calve these cows in a

separate maternity pen (apart from the "clean" cows), should not feed colostrum or milk from positive cows to heifer calves, and should remove a heifer calf from the dam as soon as possible and rear in separate facility.

Control of Vectors and Fomites

Birds, rodents, or dogs may contribute to the transmission of diseases such as Salmonella and Neospora. If practical, they should be restricted from entering feed storage and mixing areas, and feeding areas. Manure-contaminated equipment used for feeding chores may contribute to the transmission of diseases such as Johne's disease (e.g. bobcats used to push manure, then push-up feed). Traffic by way of people (dirty clothes, boots) and vehicles may also spread of many diseases.

Strategic Vaccination to Increase Immunity against Specific Diseases

While vaccination is an essential component to a good biosecurity program, vaccination programs only supplement, but do not replace, other disease-control procedures. It is highly recommended that dairy calves be vaccinated against **IBR, BVD, BRSV, PI3** and **Leptospirosis** (+/- Brucellosis in some U.S. states). It is highly recommended that yearling dairy replacement heifers, adult dairy cows, and dairy bulls be vaccinated against IBR, BVD, BRSV and Leptospirosis. Additional vaccinations which may be useful or necessary in specific herds or in specific geographic regions include Clostridial diseases, *E. coli*, Rotavirus, Coronavirus, Campylobacter fetus, Tritrichimonas fetus, Pasteurella hemolytica, and Anthrax. An example of a basic core vaccination program, by stage of life, is presented in Table 2.

Reasons for vaccine failure: Achieving proper immunization requires careful selection of an appropriate vaccine, appropriate handling and use of the product in accordance with label instructions, and vaccination of animals that are capable of mounting an immune response. Common practices which can diminish the effectiveness of a vaccination program, preventing proper immunization of the animals, include:

- Improper storage conditions (e.g. storage temperature) of vaccines.
- Mixing of two vaccines together prior to administration.
- Administration of inadequate dose.
- Administration by an improper route.
- Inactivation of vaccine by residues of disinfectants previously used to clean syringes.
- Vaccination of animals too young to respond (calves less than 4 months of age may still have circulating colostral antibodies that can block some vaccines).
- Vaccination of sick, unthrifty, or stressed animals (e.g. vaccinating too

Table 2. Example of a core vaccination program for a commercial dairy herd Note: This is an example only. It is not necessarily an exhaustive program and is NOT meant to be adopted by dairy producers without first consulting their herd veterinarian. It should be reviewed and, if necessary, modified to fit the requirements of individual producers. Additional vaccines that your veterinarian may recommend under special conditions include*: Leptospira borgpetersenii* serovar *hardjo bovis*, *Pasteurella multocida*, *Pasteurella hemolytica*, *Salmonella typhimurium*, *H. somnus*, Pink Eye, Warts, Rabies.

Class of Animal	Age / Stage of Life Cycle	Vaccine
Pre-breeding youngstock	4 months of age 5 months of age 12 months of age	IBR, BVD, PI3, BRSV (MLV) Leptospirosis - 5 way Clostridium - 7 way + tetanus Repeat '4 month' vaccines Brucellosis (optional – done in some U.S. states) Repeat '4 month' vaccines
Pre-fresh heifers with above history	35 days prior to due date 21 days prior to due date	*E. coli* mastitis K99 E. coli, Rotavirus, Coronavirus Repeat '35 day pre-fresh' vaccines
Pre-fresh older animals with above history	35 days prior to due date 21 days prior to due date	*E. coli* mastitis *E. coli* mastitis K99 E. coli, Rotavirus, Coronavirus
Lactating heifers and older animals with above history	14 DIM 30 DIM At Pregnancy confirmation (or twice/year or April/October)	*E. coli* mastitis IBR, BVD, PI3, BRSV (MLV – if open) Leptospirosis – 5 way Leptospirosis – 5 way *E. coli* mastitis (optional)
Additional if Purchased pregnant with unknown/questionable history	60 days prior to due date (or upon arrival) 30 days prior to due date (or 21-30 days post-arrival)	IBR, BVD (**Killed**), PI3, BRSV Leptospirosis – 5 way Clostridium - 7 way + tetanus Repeat '60-days prior to due date' vaccines

* Note: In general you should not give Modified Live (MLV) vaccines to pregnant animals unless you are certain that you are 'on label' for a specific product (e.g. Pfizer's Bovi-Shield Gold). Always check the label instructions and check with your veterinarian before administering any vaccine product

close to calving or transport events, or during periods of high ambient temperature).

- Failure to administer a booster or extended waiting periods between boosters.

Selecting a vaccine: When considering a vaccine for use, veterinarians should review the studies which were performed in order to qualify the product for licensure. Most, but not all vaccines, are currently required to prove both safety and efficacy. Unfortunately, challenge studies performed under research conditions do not necessarily ensure field efficacy, and measures of efficacy used in studies are not always meaningful. Use your herd veterinarian to help select the most appropriate vaccine product for your situation.

Enhance General Immunity

Good nutritional management is essential to ensure good health and to allow animals to mount a proper immune response. In addition to meeting energy, protein, fiber, and water requirements, other nutrients such as selenium, copper, zinc, iron, and vitamins A and E must be in adequate supply. General immunity is also improved by minimizing stress to the animal. Stressors to avoid or minimize include movement (i.e. transport), water or feed deprivation, sudden feed changes, temperature stress, poor air quality, overcrowding, frequent remixing into new groups, and poor stall comfort.

Housing, Sanitation, and Hygiene to Minimize the Spread of Disease

Not every animal exposed to an infectious agent will become diseased. Sufficient exposure to cause disease, called 'effective contact', may depend on the length of contact and the number of organisms transferred (dose) (Smith, 1999). It will also depend, to some degree, on the virulence of the organism and the animal's immune function (already discussed in 3c and 3d). Effective contact may be reduced by a number of ways:

Physically separate, segregate, isolate, or dilute animal density. Physical separation includes quarantine of new arrivals. Segregation may include grouping by age or class of animal (e.g. sick cow pen is separated from the maternity pen). Use of individual calf hutches is an excellent method for isolating and limiting calf exposure to pathogens from other animals. Dilution of animals simply refers to the concept of not overcrowding. If outbreaks occur, producers should have facilities to isolate clinically ill animals away from healthy animals (e.g. Salmonella or Pneumonia outbreak). Hospital facilities should be physically removed from other animals (minimum 25 feet away), and be set up so as to prevent transfer of infective manure to other areas. Walls and floors should be constructed of materials that are easily

cleaned and disinfected (i.e. wood partitions and dirt floors won't suffice).

Minimize dose load. This can be achieved through sanitation and design and use of facilities. Examples include preventing fecal contamination of feeding and watering areas as one way to minimize the transmission of Salmonella and Johne's disease, calving cows into individual maternity pens that are cleaned and freshly bedded between uses, cleaning, disinfecting, and allowing calf hutches to stand empty for 5 to 7 days between calf uses, and cleaning/sanitizing calf buckets and feeding equipment between feedings.

Minimize contact time. e.g., remove newborn calf from calving pen within 30 minutes instead of 24 to 48 hours, to prevent or limit the calf's risk of exposure to pathogens such as Salmonella*, Johne's disease*, *E.coli scours, cryptosporidiosis*, etc. in the maternity pen environment.

■ Summary

A well-designed biosecurity management plan applies the HACCP principles used by food processors to provide safer higher quality food (HACCP = Hazard Analysis – Critical Control Points). A health management program identifies health risks that each herd faces and then identifies the most important, practical, and cost effective actions that can be taken to minimize those risks in that herd. Once a biosecurity plan is in place it must be monitored to ensure it is being adhered to and to make sure it is working. For dairy producers, biosecurity may be thought of as an insurance policy, through which reduced risk can be achieved at a predetermined cost. Heifer growers may look upon biosecurity as an opportunity to add value to the product they produce.

Table 1: Review of some important infectious diseases of dairy farms: epidemiology, testing, and options for prevention and control (Note: This is meant to be a general review. Readers should refer to references cited for more detailed information)

Infectious Disease	Options for Prevention/Control
Bovine viral diarrhea virus (BVDV)	Vaccination to increase immunity: - Use MLV product with type I (provides cross-protection for type II), or use Killed product with type I & II and repeat it 2-4 weeks later. - Killed: protection 8-12 mos. - MLV: protection up to 18mos. - Refer to suggested vaccination schedule by life stages (table1) - Vaccinate new arrivals twice, 2-3 weeks apart, with killed product (if pregnant), while still in isolation. Prevent introduction & remove reservoirs: - Limit movement of animals on & off farm - Quarantine all new arrivals 30 days during which test for and cull P.I. animals. - Test for P.I. in all calves born to new arrivals. A negative heifer/cow can carry a PI calf. - If BVD identified in herd, screen and cull P.I. animals Management: - Provide excellent nutrition - Avoid stressors: crowding, environment, comfort, etc.

Infectious Disease	Options for Prevention/Control
Mycobacterium paratuberculosis (Johne's disease)	Prevent introduction & remove reservoirs: (Note: intensity of testing will depend on cost, resources, and goals of individual producer): - Maintain closed herd - Limit incoming animals to herds of known Johne's status (low risk herds); Prepurchase testing to identify infected animals - Test to identify infected animals in current herd: Options: 1) Cull infected and sick animals as able 2) keep positives but segregate & manage their female offspring to prevent transmission Prevent transmission to calves and young stock: ***Management is single most important factor affecting success of Johne's control program: - Calve cows in individual clean dry pen - Prevent fecal-oral contact of calves with milk/manure of cows - Remove calves from infected animals immediately (within 30 minutes) after birth and feed colostrum from 'negative' animals. - Pasteurize colostrum and do not pool colostrum or milk. - Feed milk replacer or pasteurized waste milk (no raw milk). - Housing: Isolate heifers from facilities (including water, pasture & manure) of older animals (Alternative: use contract heifer raiser) - Manure management: store manure away from animals & minimize flow from old to young. Improve immunity: - Vaccine: Is not available in most states. Vaccination will not prevent infection but its use in high prevalence herds may reduce the number of clinical cases (ease premature culling pressure).

Infectious Disease	Options for Prevention/Control
Contagious mastitis (Staph. aureus, Strep. agalactiae)	Prevent introduction and remove reservoirs: Source herd: - Avoid purchase of infected animals: request a bulk tank culture from herd of origin. Review 6-12 month history on herd and individual cow SCC, cultures, and treatments. - Prepurchase culture of all cows. - Prepurchase exam of udders (palpate, examine teat ends) - * Antibiotic residues: Test milk from all purchased animals for antibiotic residues before putting milk into the tank. - Milk new purchases last until get culture results. Home herd (remove reservoirs): - Monitor bulk tank and cow SCC's and bulk tank cultures. - Culture all chronic high SCC cows and all clinical mastitis cases: Strep agalactiae infection: Very good success treating infected quarters. Staph. aureus infection: Options: - Cull chronically infected cows or quarters when able. - Segregate and milk these animals last. - Treat infected quarters: (best success if not yet chronic) Dry cow: IMI antibiotic therapy (<60-70% cure rate) Lactating: extended IMI regimens (42-48% quarter cure rate (range 26-86% depending on herd)) Lactating: Combination IMI and IM antibiotic therapy 50% quarter cure rate) Combining Vaccination and extended IMI antibiotic therapy (mean 58% quarter cure rate. Herd effect on cure rate: range 29%-95% of cows, depending on herd) Prevent transmission by paying attention to: - milking machine function - milking technique & teat dipping - milkers wear latex gloves: rinse gloved hands in disinfectant between cows

	- treat new infections - dry treat all cows/quarters Vaccination: Research continuing with typically poor results. Limited evidence can use vaccination in conjunction with treatment to affect cures. Limited evidence of ability to prevent new infections or to cure existing infections. Questionable practicality vs. other control methods. Needs further research.
Mycoplasma bovis	Prevent introduction and remove reservoirs: Source herd: - see same as for *Staph. aureus* and *Strep. agalactiae* Home herd: - Surveillance by culture of bulk tank or milking string samples. Culture monthly or biweekly for at least 6 months after introduction of new animals or after last clinical case of mycoplasma mastitis. - If positive bulk tank culture, culture individual cows ➔ ID and either cull or segregate and milk last.. Prevent transmission/new infections: - Same as for *Staph. aureus* and *Strep. agalactiae* - Management: good ventilation & avoid overcrowding. - Use only commercially prepared single-use intramammary products
Neonatal calf scours*:* *Escherichia coli*, rotavirus, coronavirus, *Cryptosporidium parvum*	Improve host immunity: - Vaccinate cow at appropriate time during dry period to maximize antibodies in colostrum - Ensure calf gets adequate volume of high quality colostrum ASAP after birth (monitor serum total protein levels in calf) - Adequate nutrition, minimize stressors (e.g. cold stress) Reduce transmission/effective contacts: - SANITATION: clean dry environment, clean pens between uses, clean feeding equipment. - Prevent direct & indirect contact amongst calves, and between calves and older animals - Provide excellent ventilation

Infectious Disease	Options for Prevention/Control
Infectious bovine rhinotracheitis virus (IBR), Bovine respiratory syncitial virus (BRSV) and Parainfluenza virus type 3 (PI_3)	Improve host immunity: - Excellent vaccines for IBR - see recommended vaccination protocol (Table 1) - Ensure calf gets adequate volume of high quality colostrum ASAP after birth Reduce transmission/effective contacts: - avoid overcrowding - minimize stressors - sanitation - provide good ventilation, nutrition - prevent direct and indirect contact amongst calves, and between calves and older animals
Leptospirosis (multiple serovars: e.g. *L. hardjo, pomona, canicola, icterohemorrhagiae, grippotyphosa, szwajizak*)	Improve host immunity: - Vaccination every 6 months. Refer to vaccination schedule (Table 1). - Good nutrition - Minimize stressors. Eliminate carriers/reservoirs: - I.M. injection with LA 200 will clear Lepto from the majority (95%) of infected animals (but won't prevent reinfection). - Clean, dry environment. -

Infectious Disease	Options for Prevention/Control
Salmonella (Several different serotypes: e.g. *S. anatum, dublin, montevideo, typhimurium, newport, muenster, enteritidis*)	Reduce transmission/effective contact: SANITATION!!!: - Prevent fecal contamination of feedstuffs, feeding surfaces, water troughs, feeding equipment. - Control programs for rodents, flies, birds (protect feed storage and feeding areas) - Clean calf feeding equipment between uses. - Mix feed just prior to consumption - Avoid use of recycled flush water. - Clean and disinfect maternity pens between cows. - Isolate clinically ill animals from rest of herd. Improve host immunity: - Good colostral management and nutrition for calves. - Avoid stressors (environment, poor ventilation, heat stress, lack of feed, sudden feed changes, transport, crowding) - Vaccination of dam with core antigen vaccines (J-5 (UpJohn Inc., Kalamazoo, Michigan) or Endovac Bovi (Immvac, Inc., Columbia, MO)) may decrease the severity of clinical signs associated with gram negative infections. See Vaccine schedule (Table 1). - Newer SRP vaccine reduces shedding in older animals (untested and unlabelled for calves < 6 months old). Prevent introduction/Remove reservoirs: - Test and cull carrier animals (*if practical*) - Closed herd policy - May use ELISA or fecal culture to test newly purchased animals while in quarantine. - Don't allow rendering trucks access to feed or animal housing areas. Zoonosis: Farm families & employees at risk if in contact with infected cattle (especially very old and very young). Do not drink unpasteurized milk.

Infectious Disease	Options for Prevention/Control
Bovine Leukosis (leukemia) virus (BLV)	No vaccine available. Planning a control program should include a cost/benefit analysis to evaluate potential return on investment. Minimize risk of transfer within herd: - Use syringe needles and palpation sleeves on only one animal. - Use non-bloody dehorning methods - Sterilize tattoo and surgical instruments between animals. Remove reservoirs (if practical) : - Screen incoming animals for infection - Test and segregate or cull infected animals
Hairy Heel Warts (papillomatous digital dermatitis or PDD)	Prevent introduction to herd: - Purchase animals from closed herds known to be free of PDD. - Visual inspection of feet of prospective new additions. - Have new additions walk through medicated footbath and trim & inspect feet during quarantine period. - Have foot trimmer clean and disinfect tools between herds. Prevent transfer within herd: - Have foot trimmer disinfect tools between animals. - Treatment/control options include antimicrobial treatment via medicated footbaths, topical application (spray or apply directly under a bandage), or systemic treatment (refer to Shearer et al., 1998) for extensive review of treatment/control options). Increase host immunity: - Trim feet regularly. - Clean dry environment, non-abrasive flooring, comfortable stalls - Vaccine: available for *serpens* bacteria (different organism) (Hygieia Biological Laboratories, Woodland, California). However, vaccine efficacy has not been consistently demonstrated.

Infectious Disease	Options for Prevention/Control
Neospora caninum	To prevent congenital infection: Test new additions to herd: only purchase if seronegative animals. Test aborting cattle (serology), their dams and daughters, and cull if seropositive. To prevent horizontal infection: Prevent access of dogs to barns, feed storage areas, feeding areas, placentas, dead calves, aborted fetuses Prompt removal of fetuses, dead calves, and placenta. Use individual calving pens that are cleaned and disinfected between calvings. Enhance immunity? - Vaccine available but has unknown efficacy.

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