Biosecurity in Upper Midwest Dairy Herds
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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. A biosecurity program includes management practices that:

- Reduce the likelihood of introducing a new disease from an external source
- Reduce the spread of infectious disease already on the dairy (biocontainment)
- Reduce the severity and economic impact of existing infectious diseases already present on the dairy.

The objectives of this paper are to:
- Review the steps involved with developing a biosecurity program:
  - Risk assessment
  - Risk management and risk communication
- Discuss the 3 basic principles of a biosecurity program:
  - Prevent introduction of new diseases to the herd and eliminate/neutralize current reservoirs and sources of infection.
  - Increase the animal’s ability to resist disease.
  - Minimize the spread of disease within the herd.
- Identify some of the important infectious diseases in the upper mid-west states and briefly review their epidemiology, available tests, and potential methods for prevention and control.

Steps Involved in Developing a Biosecurity Program

1. 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.

Risk assessment includes:

a) Identify the goals of the dairy operation.
This relates to the products sold now and in the future. For most commercial
dairies this includes milk and dairy beef from cull cows, but may also include calves, heifers, or cows culled for dairy use. For some producers this may include marketing animals, embryos, or semen.

b) Identify and prioritize the key hazards on each operation in relation to the goals. This involves identifying those infectious diseases most likely to threaten the operation, determination of the likelihood of these hazards occurring (with respect to current preventive plans), and determination of the consequences and magnitude of the impact of these hazards.

c) Evaluate methods of transmission of key pathogens and understand the epidemiology of the disease (e.g. incubation period, duration of clinical disease, duration of shedding, survival or growth in the environment).

d) Evaluate potential methods of pathogen control and changes necessary to implement a preventive biosecurity program. The benefits of controlling risks must be weighed against the costs of such a program. From a practical sense, and so not as to be overwhelmed by the process, producers and veterinarians may want to begin by selecting and then focussing on three management areas that are believed to be most important in allowing introduction or transmission of disease. Once management of these three areas is being done well, the program could be expanded.

2. **Risk management and risk communication**

Once risk assessment is performed, the veterinarian and management team can plan and then implement a preventive biosecurity program. From the point of view of potential liability for the consulting veterinarian, it is important that the final plan be documented and communicated to all members of the management team. This includes the veterinarian’s involvement in training the management team as to the importance of proper vaccine handling, vaccination technique, etc. After its implementation, a monitoring or surveillance program must be put into place to evaluate the plan’s effectiveness and to identify new emerging diseases. This requires accurate diagnosis of diseases and consistent recording of disease occurrences. Any animal that dies on the dairy should 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.

**Basic Principles of a Biosecurity Plan**

The infectious disease triad:

ANIMAL + INFECTIOUS AGENT + ENVIRONMENT = DISEASE
Infectious diseases of cattle result from the interaction between the animal, the environment, and the infectious agent. The veterinarian and producer must consider the most practical and cost-effective ways to manipulate any or all of these 3 components of the disease triad in order to develop an effective biosecurity program. There are just 3 principles which need to be addressed in any biosecurity plan (Smith, 1999):

1. Prevent introduction of new diseases into the herd and eliminate or neutralize reservoirs/sources of infection
2. Increase the animal’s ability to resist disease.
3. Decrease the within-herd exposure (minimize the spread of disease)

1. Prevent introduction of new diseases into the herd and eliminate or neutralize reservoirs/sources of infection

In an ideal world, introduction of infectious diseases could be best avoided by maintaining a ‘closed herd’. This would preclude such practices as 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 expanding dairies, dairies should ultimately try to move towards a ‘closed herd’ situation as soon as that option becomes feasible. If new animals are to be introduced to the herd, steps can be taken to minimize the risks of introducing new diseases:

1.a Prevent the introduction of diseases when purchasing new cattle:

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 or individual mastitis culture results should be reviewed for the source herd.
- For individual mature cows 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.
Due to the dynamics of some diseases and the imperfection of 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 stage I of the disease. Under these circumstances, we can still dramatically lower the risk of introducing a Johne’s-infected animal by purchasing animals from herds that have tested for Johne’s disease and are known to be low risk (low prevalence) herds (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 from Wells, 1999)

Although there is no universal consensus on which diseases should be tested for, diseases worth consideration include:
- BVD virus persistent infection (PI)
- *Neospora caninum*
- Mastitis caused by *Staphylococcus aureus, Streptococcus agalactiae* and *Mycoplasma bovis*
- Johne’s disease
- Bovine leukemia (optional)

When deciding whether to test for a specific disease, one must consider such factors as the accuracy of the diagnostic test being used (will it accurately identify all infected animals as positive and all uninfected animals as negative?), disease epidemiology, and the financial costs/benefits relative to the short and long-term profit for the dairy. Dr. Kenn Buelow will be presenting a discussion on how disease and test characteristics may be considered in trying to make recommendations for diagnostic testing, using Johne’s disease and Staphylococcus aureus mastitis as examples (see paper in these proceedings).

Because it takes 3-4 weeks to get results from some tests, 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.

**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 being used.
- 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, and should not be allowed 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 vaccine schedule).
- Collect the necessary samples to test for infectious disease status (see above). Purchased cattle should use a medicated foot bath upon arrival and should have their feet 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.

The quarantine period serves to protect both 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 milking cows. In this situation the buyer may arrange to have animals tested and vaccinated while they are still on the seller’s property.
- Bovine leukosis (optional)

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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 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.

1.b Eliminate or neutralize sources/reservoirs of the infectious agent

Test to identify carrier animals already in the herd

The diseases to consider testing for are the same as for new arrivals. While the concept of identifying and then culling carrier animals is desirable, it must be possible to accurately identify an animal's infection status for these test and cull programs to be effective. Once identified as infected, and depending on the nature of the specific disease, options may be to cull infected animals, treat (e.g. Strep. agalactiae mastitis cows), or to manage infected animals differently (e.g. segregate Staph. aureus mastitis cows). It may not be economically feasible to cull all animals identified as infected. Depending on the nature of the disease and how it is spread, infected animals may remain as productive units in the herd, so long as they are managed to prevent transmission of infection to herdmates or offspring. For example, a cow that tests positive for Johne’s disease may stay in the herd for several years without developing clinical signs of the disease. The producer can reduce the chance that her female offspring will become infected by taking steps such as not allowing the calf to drink her colostrum or milk, by removing the calf from the maternity pen immediately after birth, and by rearing the calf in clean facilities that are physically removed from the adult herd.

Control of vectors: e.g. 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 storing/mixing areas and feeding areas.

Control of fomites: e.g. Manure-contaminated equipment used for feeding chores may contribute to the transmission of diseases such as Johne’s disease. Traffic by way of people (dirty clothes and boots) and vehicles may also contribute to the spread of many diseases.

2. Increase the Animal’s Ability to Resist Disease

2.a Strategic Vaccination

Designing a strategic vaccination program requires determining what diseases to vaccinate against, which animals will benefit from immunization, and when they need the protection the most. 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, Leptospirosis, and (+ Brucellosis). 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, Staphylococcus aureus, Campylobacter fetus, Tritrichomonas fetus, Pasteurella hemolytica, and Anthrax. An example of a vaccination program, by stage of life, is presented in Table 1.

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. The veterinarian should be involved in educating the producer about the critical importance of each of these factors. Common practices which can diminish the effectiveness of a vaccination program include:
- improper storage and temperature
- mixing of two vaccines together prior to administration
- administration of inadequate dose
- administration by an improper route
- inactivation of vaccine by residues of disinfectants used to clean syringes
- vaccination of animals too young to respond (less than 4 months of age may still have colostral antibodies)
- vaccination of sick, unthrifty, or stressed animals (i.e. vaccinating too close to calving, transport, 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 ensure field efficacy, and measures of efficacy used in studies are not always meaningful. Veterinarians can use the following check-list of key elements to look for when examining the clinical research published for a particular vaccine:
1. Has the vaccine been laboratory and field-tested in randomized controlled clinical trials?
2. Was the vaccine assigned randomly to trial animals?
3. Were the control groups monitored concurrently with the treated groups? (vs. historical controls)
4. Were the people involved with measuring study outcomes blinded to the treatment groups to reduce bias?
5. What other potential biases may be evident?
6. How were the trial animals challenged? Without natural challenge, in which both the control groups and the treated groups are exposed equally and under field conditions.
you won’t know a) was disease actually present and b) would the vaccine work under field conditions?

7. Was the measure of outcome meaningful? Looking at serological or culture results is interesting but they do not tell us if the vaccine actually reduces morbidity and mortality, or improves production.

8. How likely was the result a chance finding? Look at p values, but also estimate the magnitude of the vaccine effect, considering the number of animals in the trial.

9. What are the differences between the trial conditions and trial animals, as compared to farms and animals in your practice?

2.b 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 include movement (i.e. transport), water or feed deprivation, sudden feed changes, temperature stress, air quality, and stall comfort. Environmental stress should be minimized.

3. Decrease the within-herd exposure (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 innate immunity (already discussed). Effective contact may be reduced by a number of ways:

3.a 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). Isolation of individuals may refer to individual calf hutches. Dilution of animals simply refers to the concept of not overcrowding. If outbreaks occur, producers should have facilities to isolate clinically ill animals individually (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).

3.b Minimize dose load. This can be achieved through sanitation (e.g. prevent fecal contamination of feeding and watering areas as one way to minimize the transmission of Salmonella), or use of prophylactic medicines (e.g. use of coccidiostats in rearing of replacement heifers in order to reduce shedding).
3.c **Minimize contact time.** e.g., remove newborn calf from calving pen within 30 minutes instead of 3 days to prevent exposure to pathogens such as Salmonella, *M. paratuberculosis*, *E. coli*, etc.

### Major infectious diseases of cattle in the upper Midwest

The major infectious diseases of cattle in the upper Midwest include:
- Bovine viral diarrhea virus (BVDV)
- Johne’s disease (*Mycobacterium paratuberculosis*)
- Contagious mastitis (*Staph aureus, Strep. Agalactiae*)
- IBR, BRSV and PI₃ viruses
- *E. coli*, rotavirus and coronavirus
- Salmonellosis
- *Mycoplasma bovis*
- Hairy heel warts
- Leptospirosis
- Neospora caninum
- Bovine leukosis virus (BLV)

A brief review of the epidemiology of these diseases, methods of testing, and some potential methods for prevention and control are presented in Table 2.

### Summary

A well-designed biosecurity management plan is similar to 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 associated with the life stages of the animals (hazard analysis) and then identifies the important control points (critical control points) that can be applied to minimize those risks. The risk management, risk assessment, and risk communication steps are critical to achieving a successful biosecurity program. 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. Recommendations for basic vaccination program of a commercial dairy herd

Note: this is not necessarily an exhaustive program. It should be reviewed and, if necessary, modified to fit the requirements of individual producers (e.g. herds using natural breeding may consider vaccinating bulls and cows against Vibrisosis (*Campylobacter fetus*).)

<table>
<thead>
<tr>
<th>Class of Animal</th>
<th>Age / Stage of Life Cycle</th>
<th>Vaccine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-breeding youngstock</td>
<td>4 months of age</td>
<td>IBR, BVD, PI3, BRSV,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Leptospirosis - 5 way</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Clostridium - 7 way + tetanus</td>
</tr>
<tr>
<td></td>
<td>5 months of age</td>
<td>Repeat '4 month' vaccines</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Brucellosis</td>
</tr>
<tr>
<td>Pre-fresh heifers with above history</td>
<td>12 months of age</td>
<td>Repeat '4 month' vaccines</td>
</tr>
<tr>
<td></td>
<td>35 days prior to due date</td>
<td>J5 E. coli</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Scourguard 3K/C (K99 E. coli, Rotavirus, Coronavirus)</td>
</tr>
<tr>
<td>Pre-fresh older animals with above history</td>
<td>21 days prior to due date</td>
<td>Repeat '35 day pre-fresh' vaccines</td>
</tr>
<tr>
<td></td>
<td>35 days prior to due date</td>
<td>J5 e. coli</td>
</tr>
<tr>
<td></td>
<td>21 days prior to due date</td>
<td>J5 E. coli</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Scourguard 3K/C (K99 E. coli, Rotavirus, Coronavirus)</td>
</tr>
<tr>
<td>Lactating heifers and older animals with above history</td>
<td>14 DIM</td>
<td>J5 e. coli</td>
</tr>
<tr>
<td></td>
<td>30 DIM</td>
<td>IBR, BVD, PI3, BRSV</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Leptospirosis – 5 way</td>
</tr>
<tr>
<td></td>
<td>At Pregnancy confirmation (or twice/year or April/October)</td>
<td>Leptospirosis – 5 way</td>
</tr>
<tr>
<td></td>
<td></td>
<td>J5 e. coli (optional)</td>
</tr>
<tr>
<td>Additional if Purchased pregnant with unknown/questionable history</td>
<td>60 days prior to due date (or upon arrival)</td>
<td>IBR, BVD (Killed), PI3, BRSV</td>
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<tr>
<td></td>
<td></td>
<td>Leptospirosis – 5 way</td>
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<td></td>
<td></td>
<td>Clostridium - 7 way + tetanus</td>
</tr>
<tr>
<td></td>
<td>30 days prior to due date (or 21-30 days post-arrival)</td>
<td>Repeat '60-days prior to due date' vaccines</td>
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Table 2: Review of some important infectious diseases of Midwest 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).

<table>
<thead>
<tr>
<th>Infectious Disease</th>
<th>Types of disease</th>
<th>Means of transmission</th>
<th>Tests Available</th>
<th>Options for Prevention/Control</th>
</tr>
</thead>
</table>
| Hovine viral diarrhea (BVD) | - Strains classified as type I or type II, cytopathogenic or non-cytopathogenic, and ranging from extremely low virulence causing mild, almost undetectable disease, to extremely high virulence, causing sudden and extensive death loss in a herd. | Reservoirs are persistently infected (PI) cattle (continuous shedding) and acutely infected cattle (shed 10-14 days). | **Step 1:** Options for answering the question: is BVD present in the herd?  
  a) Serum (virus) neutralization (SN): paired serum samples: see > 4-8 fold increase in titers in cows that recently aborted. (must test for type I and II)  
  b) SN: presence of titers in precolostral calves.  
  c) SN: presence of titers in unvaccinated sentinel calf (>8 mos. old) (i.e. keep steer calf) (must test for type I and II)  
  d) Virus Isolation: isolate BVD from acutely infected/ill animals (buffy coat preferred sample (whole blood))  
  e) Virus isolation: isolate BVD from tissue samples (i.e. aborted fetus) | **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 18 mos.  
  - Refer to suggested vaccination schedule by life stages (table 1)  
  - 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.  
    - If BVD identified in herd, screen herd and cull P.I. animals  
    - Management:  
      - Provide excellent nutrition  
      - Avoid stressors: crowding, environment, comfort, etc. |
|                    | - Repro Disease: First trimester exposure: Decreased conception rates, Early embryonic death, Stillbirths, mummified calves, persistently infected (PI) calves. Second trimester exposure: Abortions, congenital defects, occasional P.I. calves. Third trimester exposure: Occasional abortion, birth of normal calves carrying BVD antibodies. | **Transmission:** Direct contact with infected cattle or their body fluids: fecal-oral, nasal secretions, saliva, milk, sexual (infected semen or embryos) or In-utero transmission  
  - Incubation: 5-10 days  
  - Duration of clinical disease: 14 days  
  - Survival in environment: up to 14 days  
  - Grow in environment: no | **Step 2:** Sequence of steps for answering the question: are there P.I. animals in the herd?  
  a) Virus isolation test on bulk tank samples or milking string samples (chilled, not frozen, 200 ml volume, up to 250 animals commingled, cost: $25-50. Available through Wisconsin and Cornell animal health laboratories)  
  b) Virus isolation test on individual animals (note: cannot pool serum samples)  
  ➔ cull all P.I. animals |  |
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<tr>
<td><em>Mycobacterium paratuberculosis</em>&lt;br&gt;(John's disease)</td>
<td>Granulomatous enteritis causing chronic intractable diarrhea and weight loss.&lt;br&gt;Stages of disease:&lt;br&gt;1. Silent infection: no shedding of organism&lt;br&gt;2. Subclinical disease: may have detectable antibodies, may shed low numbers in feces&lt;br&gt;3. Clinical disease: gradual weight loss, intermittent diarrhea, usually shedding and usually positive antibody response (avg. age 2-5 years)&lt;br&gt;4. Advanced clinical disease: weak, emaciated, shedding large numbers in feces</td>
<td>Youngest animals most susceptible to infection.&lt;br&gt;Prenatal transmission:&lt;br&gt;- asymptomatic cows: 0-10% of fetuses infected in-utero&lt;br&gt;- symptomatic cows or heavy shedders: 20-40% fetuses infected</td>
<td>Fecal culture: Sensitivity: (avg. 40-50%)&lt;br&gt;Stage 1: not detectable&lt;br&gt;Stage 2: &lt;25%&lt;br&gt;Stage 3: &lt;85%&lt;br&gt;Specificity: 100%&lt;br&gt;Turn around: slow (up to 12-16 weeks)&lt;br&gt;Medicine Antibody detection:&lt;br&gt;ELISA, AGID, CF tests.</td>
<td>Prevent introduction &amp; remove reservoirs: (Note: intensity of testing will depend on cost, resources, and goals of individual producer):&lt;br&gt;- Maintain closed herd&lt;br&gt;- Limit incoming animals to herds of known Johne’s status (low risk herds)&lt;br&gt;- Prepurchase testing to identify infected animals&lt;br&gt;- Test to identify infected animals in current herd: Options: 1) Cull infected and sick animals as able 2) keep positives but segregate &amp; manage their female offspring to prevent transmission.</td>
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| Contagious mastitis (Staph aureus, Strep agalactiae) | Chronic subclinical or clinical mastitis with associated costs due to lost production, treatment, discarded milk, and involuntary culling | Staph aureus and Strep agalactiae:  
- *Transfer of organism in milk from infected gland to uninfected glands via fomites such as milking equipment, common towels or milker’s hands. (Udder is only reservoir for Strep agalactiae) | Monitoring/Screening tests to identify suspect herds/cows/quarters:  
- Monitor bulk tank and individual cow somatic cell count (SCC)  
- California Mastitis Test (CMT)  
Diagnosis of Infection:  
Bacterial culture of milk:  
  a) Bulk tank: identify presence of infection within the herd.  
  b) Individual cow culture: composite or quarter samples. (Sensitivity, specificity & costs of culture; refer to Dr. Buelow’s talk). Turn around: 2-3 days.  
Antigen tests:  
PCR test: still in development  
Antibody tests:  
(e.g. Prostaph test): Specificity: very poor (many false positives) | 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 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) |
| Staph aureus | Possible additional role of flies in spreading Staph aureus | Transfer from colonized milker’s hands, or teat skin | | |

Prevent transmission:  
- 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 (varied results). Limited evidence can use in conjunction with treatment to effect cures. Limited evidence of ability to prevent new infections or to cure existing infections. Questionable practicality vs. other control methods. Needs further research. |
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| Mycoplasma bovis  | Clinical and subclinical mastitis characterized by:  
- Can see herd outbreaks  
- Multiple quarters often involved  
- Cow not systemically ill  
- Treatment is ineffective  
- Often negative culture results due to intermittent shedding  
- Some infections resolve spontaneously while others become chronic infections.  
Also causes Arthritis, Pneumonia, Metritis, Abortions, and otitis media (calves) | Contact with respiratory carrier or infected milk  
- The organism is introduced to new quarters and cows via the mechanisms involved in spreading contagious mastitis  
- Can be introduced to udder by poor hygiene during intramammary infusion  
- May infect calves fed discarded mastitic milk | Herd diagnosis: Bacterial culture of milk from bulk tank.  
Individual animal diagnosis: culture milk from individual cow.  
Note: Culture requires special medium and microaerophilic (5-6% C02) environment. Can't culture on blood agar plates.  
Turn around: 10-14 days  
Sensitivity: intermittent shedding → false negatives | Prevent introduction and remove reservoirs:  
Source herd:  
- see same as for Staph. aureus and Strep. agalactiae  
Home herd:  
- Surveillance by bulk tank cultures (<1000 cows) or milking string sample cultures. Culture monthly or biweekly for at least 6 months after introduction of new animals or after last clinical case of mycoplasmastitis.  
- If positive bulk tank culture, culture individual cows ID and either cull or segregate and milk last.  
Prevent transmission/new infections:  
- see same as for Staph. aureus and Strep. agalactiae  
- Management: good ventilation & avoid overcrowding.  
- Use only commercially prepared single-use intramammary products |
| Neonatal calf GIT diseases: Escherichia coli, rotavirus, coronavirus | E. coli: 1 – 4 days of age. Watery diarrhea, dysentery, dehydration, +/- endotoxemia, bacteremia, and sequelae of bacteremia  
Rotavirus: Diarrhea at 4-14 days of age (may be younger & older)  
Coronavirus: Diarrhea at 4-30 days of age. | Fecal-oral transmission  
Reservoirs are the environment and infected calves. | No surveillance/screening tests as are ubiquitous.  
Tests for diagnosis of infectious agent in clinical cases: Fluorescent antibody techniques used for K99 e. coli and virus identification in gut tissues. ELISA to detect antigen in feces.  
Electron microscopy of feces: (rota/corona viruses) | Improve host immunity:  
- Vaccinate cow at appropriate time during dry period to maximize antibodies in colostrum  
- Ensure calf gets adequate volume of high qualitycolostrum ASAP after birth (can monitor adequacy of passive transfer by measuring serum total protein levels in calf)  
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 |
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<td>Infectious bovine rhinotracheitis virus (IBR), Bovine respiratory syncitial virus (BRSV), and Parainfluenza virus type 3 (PI₁)</td>
<td>IBR: (bovine herpes virus type I) - Respiratory disease - Neurological disease - Reproductive disease: infectious pustular vulvo-vaginitis (IPV), embryonic death, abortion, stillbirth, birth of weak calves PI₁: Respiratory disease of calves BRSV: respiratory disease of calves and naive adult cattle</td>
<td>Widely distributed in cattle population. IBR: Transmission via direct contact with infected animals (nasal discharge, genital secretions, semen, fetal tissues and fluids). PI₁ and BRSV: Direct contact with infected animals, airborne transmission</td>
<td>No surveillance/screening tests as are ubiquitous. Tests for diagnosis of infectious agent in clinical cases: IBR: Fluorescent antibody (F.A.) test of aborted fetal tissues BRSV, IBR, PI₁: - Serology: seroconversion in paired serum samples - Immunohistochemistry or direct ELISA on cells from trans-tracheal wash or A-V lung lobe - Virus isolation from nasal swabs or from other tissues on necropsy (rarely successful)</td>
<td>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</td>
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<td>Leptospirosis (multiple serovars e.g. <em>L. hardjo</em>, <em>pomona</em>, <em>canicola</em>, <em>icterohemorrhagiae</em>, <em>grppatphouna</em>, <em>szwajzak</em>)</td>
<td>Repro Disease most commonly associated with <em>L. hardjo</em>. Abortion (usually between 4 months to term but occasionally in first trimester). Also infertility, E.D., stillbirths, and birth of weak calves. Most underdiagnosed bacterial cause of abortion in cattle.</td>
<td>Leptospira spp. are shed in urine of carriers (will shed for weeks, months, and even years) Organisms survive in surface water, streams, and moist alkaline soil (are ubiquitous in the environment). - Infect new animals by penetrating mucous membranes (eye, mouth, vagina, etc.). Infection can persist in brain, eye, reproductive tract, and kidney (immunologically privileged sites).</td>
<td>No practical test to screen to identify carrier animals. Diagnosis after abortion: - F.A. of fetal tissues: few false positives (cortico-medullary junction) - Serology: seroconversion (elevated titers (M.A.T.) in paired serum samples as compared to gestationally matched pregnant animals. (Note: Microagglutination (M.A.T.) tests have poor sensitivity (30-40%) are false negatives) - Submit urine samples for culture (rarely successful) (technique: 1. Elicit to urinante. 2. Give laxis I.V. 3. Collect midstream urine sample 4. Submit to lab ASAP.</td>
<td>Improve host immunity: - Vaccination every 6 months. Refer to vaccination schedule (Table 1). U.S. vaccines not protective against <em>L. hardjo</em>. - Good nutrition - Minimize stressors. Eliminate carriers/reservoirs: - I.M. injection with LA 200 will clear Lepto from the majority (95%) of infected animals. - Clean, dry environment.</td>
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<td>Salmonella ( Several different serotypes: e.g. S. anatum, dublin, montevideo, typhimurium, newport, muenster enteritidis)</td>
<td>Clinical disease after infection depends on innate resistance of host, infectious dose received, and virulence of strain of organism</td>
<td>Primarily fecal-oral transmission</td>
<td>Postmortem Diagnosis</td>
<td>Reduce transmission/effective contacts: SANITATION!!:</td>
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<td>S. dublin: host-adapted to cattle. Typically affects: Calves: 10 days – 3 months</td>
<td>Carriers will shed in nasal secretions, saliva, milk, and intra-uterine. Sheding may continue for several months.</td>
<td>Culture from tissues</td>
<td>- Prevent fecal contamination of feedstuffs, feeding surfaces, water troughs, feeding equipment.</td>
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<td>S. Typhimurium (group B1): most commonly isolated in epidemics of adult cattle</td>
<td>Shed not only by bovine, but other species including cats, dogs, birds, rodents</td>
<td>Antemortem diagnosis in clinically ill animals: Fecal culture (requires selective enrichment media), blood or milk culture.</td>
<td>- Control programs for rodents, flies, birds (protect feed storage and feeding areas)</td>
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<td>Will cause disease in calves, and stressed cows/fresh cows</td>
<td>Survives long periods in moist soil, feces, animal feeds, and the environment (9 mos.-years), including lagoons (flush water)</td>
<td>Screening tests:</td>
<td>- Clean calf feeding equipment between uses.</td>
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<td>Syndrome:</td>
<td>Epidemics if introduced to naïve herds</td>
<td>Replicates rapidly in mixed wet feeds.</td>
<td>- Fecal culture: Performed in case of herd problem which is not being controlled through sanitation and other management practices. ➔ identify and culture subclinical carriers or ELISA test (paired serology) to detect carriers of S. dublin (Salmonella Serology Laboratory of B.P. Smith, University of California-Davis): If persistently high titers on two separate tests performed 60-90 days apart, consider as carrier and cull.</td>
<td>- Mix feed just prior to consumption</td>
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<td>1. Peracute septcemia with sequelae (e.g. CNS disease)</td>
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<td>- Avoid use of recycled flush water.</td>
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<td>2. Acute &amp; chronic enteritis (dehydration, diarrhea) with associated weight loss, and production losses</td>
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<td>- Clean and disinfect maternity pens between cows.</td>
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<td>3. Abortion</td>
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<td>- Isolate clinically ill animals from rest of herd.</td>
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<td>4. Subclinical carrier state (active or intermittent shedders, or latent state)</td>
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<td>Improve host immunity:</td>
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<td>- Good colostral management for calves.</td>
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<td>- Avoid stressors (environment, poor ventilation, heat stress, lack of feed, sudden feed changes, transport, crowding)</td>
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<td>- Vaccination with core antigen vaccines (J-5 (UpJohn Inc., Kalamazoo, Michigan) or Endovac Bovi (Immvac, Inc., Columbia, MO)): decrease the severity of clinical signs associated with gram negative infections. See Vaccine schedule (Table I).</td>
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<td>Prevent introduction/Remove reservoirs:</td>
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<td>- Test and cull carrier animals (if practical)</td>
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<td>- Closed herd policy</td>
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<td>- May use ELISA or fecal culture to test newly purchased animals while in quarantine.</td>
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<td>- Don't allow rendering trucks access to feed or animal housing areas.</td>
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<td>Zoonosis: Farm families &amp; employees at risk if in contact with infected cattle (especially very old and very young). Do not drink unpasteurized milk.</td>
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<td>Bovine Leukosis (leukemia) virus (BLV)</td>
<td>Malignant neoplastic conditions commonly affecting multiple organs (heart, abdominal, lymph nodes). Symptoms usually occur in less than 5% of infected cows, and usually after 5 years of age. Economic losses due to premature culling, replacement costs, and condemnation at slaughter. I economically important, due to international trade restrictions, to producers exporting semen, embryos, or animals.</td>
<td>Virus transmitted through transfer of virus-infected white blood cells (i.e. through contaminated injection needles, dehorning, tattooing, or surgical instruments, palpation gloves if rough, inexperienced palpator)</td>
<td>Screening test; ELISA or AGID to detect antibodies in animals &gt; 6 months of age. Sensitivity: 99% Specificity: 99%</td>
<td>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</td>
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<td>Hairy Heel Warts (papillomatous digital dermatitis or PDD)</td>
<td>Organism thought to be a Treponema spirochete (bacterium) Lameness Lesions range from painful, moist, strawberry-like lesions to raised, hairy, wart-like lesions Lesions usually located on the rear of the foot between the bulbs of the heel Lesions are very painful Recurrence rate is high (approx. 50% in 2-7 months post-treatment), suggesting short-lived natural immunity</td>
<td>Contact with environment of infected cows; highly contagious May be transmitted on fomites (e.g. hoof trimming equipment) Risk factors: - Moist/wet/muddy conditions - Rough floors may lead to increased wearing and abrasions, providing entry points for the organism</td>
<td>Visual screening for lameness and typical lesions</td>
<td>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 &amp; 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). Efficacy not yet demonstrated.</td>
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<td><em>Neospora caninum</em></td>
<td>Abortion (usually between 5-7 months of gestation)</td>
<td>An intracellular protozoal parasite related to toxoplasma gondii.</td>
<td><strong>Screening tests:</strong> ELISA (IDEXX Laboratories, Inc.) to detect positive antibody titer.</td>
<td>To prevent congenital infection:</td>
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<td>Some calves are stillborn, or exhibit signs of neuromuscular disease and then die within 2 weeks of life.</td>
<td>Vertical transmission: Is almost 100% of transmission is in-utero from cow to fetus, resulting in birth of live full-term calves with congenital infection.</td>
<td>Sensitivity: 88.6% Specificity: 96.5%</td>
<td>- Test new additions to herd: only purchase if seronegative animals.</td>
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<td>Abortion occurs in 5-20% of infected animals. Most abort only once, but some may have several abortion episodes.</td>
<td>Horizontal transmission: Carnivores (Dog and probably Coyote) identified as definitive host. Carnivores are infected when they eat animal tissues (usually fetuses and placenta) containing either tachyzoites or bradyzoites of <em>N. caninum</em>. The organism then replicates in GIT and oocysts are shed in the feces for 7-14 days. It is possible that cows are infected from ingestion of infective oocysts in feed or water contaminated with infective dog feces (not yet proven). There may be other ways cattle could become infected.</td>
<td><strong>Diagnostic tests:</strong></td>
<td>- Test aborting cattle (serology), their dams and daughters, and cull if seropositive.</td>
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<td>Prevalence: Approximately 6.5% of dairy cows in the upper Midwest. Approx. 22% in the Southwest. Within-herd prevalence in Wisconsin ranges from 1% to 30%.</td>
<td>Abortion storms suggest a common point source of exposure (e.g. fecal contaminated feed and/or water)</td>
<td>In aborted fetus: Histopathology: Usually mild multifocal necrotizing, non-suppurative encephalitis, and lymphocytic myocarditis. ELISA: of fetal thoracic fluid.</td>
<td>To prevent horizontal infection:</td>
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<td>In aborting dam: ELISA: submit sera within 3 weeks of abortion. Compare results to those of gestationally matched non-aborting animals.</td>
<td>- Prevent access of dogs to barns, feed storage areas, feeding areas, placentas, dead calves, aborted fetuses</td>
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<td>- Prompt removal of fetuses, dead calves, and placenta.</td>
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<td>- Use individual calving pens that are cleaned and disinfected between calvings.</td>
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<td>Enhance immunity?</td>
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<td>- Vaccine currently being tested: unknown efficacy</td>
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References:


