VMS 361
Animal Disease Management Principles
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What are the best ways to deal with herd infectious disease problems?
Given that most infectious agents remaining as problems (we’ve gotten rid of the easy ones):
- Are ubiquitous (holoendemic)
  - If they haven’t been found on a farm, they likely haven’t been
    looked for hard enough
- Are opportunists
  - Survive well in the environment, often months
  - Aren’t reliably curable with drugs
  - Establish carrier states in herdmates who then shed it
  - Vaccines are not 100% effective (if even available)
  - Often co-evolved with their bovine host

What is the best approach and what is needed for that approach?

Animals in a group have different infection and disease statuses

<table>
<thead>
<tr>
<th>Exposure Status</th>
<th>Un-exposed</th>
<th>Exposed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infection Status</td>
<td>Un-infected</td>
<td>Infected</td>
</tr>
<tr>
<td>Disease Status</td>
<td>Sub-Clinical</td>
<td>Clinical Disease (Apparent)</td>
</tr>
<tr>
<td></td>
<td>Morbidity (Sickness)</td>
<td>Mortality</td>
</tr>
<tr>
<td></td>
<td>Mild</td>
<td>Severe</td>
</tr>
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</table>

In a herd you have to manage animals in all of these states

Goal: Separate the susceptible from the potential subclinical

The disease “Iceberg” means most diseased animals are not detectable visually
- Most infections are subclinical
  - Typically > 10:1
- Can’t identify every infected animal easily
- Important because some animals are more susceptible than normal
  - Neonates
  - Animals with other diseases

Due to the “iceberg phenomenon,” most disease loss in a herd is hidden

The performance loss from subclinical disease is often the same as that from clinical disease

469 steers followed from birth to feedlot to slaughter
- 35% (164) treated for BRD
- Pulmonary lesions at slaughter:
  - 78% (128) of treated steers
  - 68% (207) of untreated steers (subclinical!)
  - 0.2 lb ADG reduction
  - 46 lb slaughter weight reduction

Prevention is key to preventing production loss!
Prevention beats cures every time

Clinical cases are the “tip of the iceberg” red flags

One goal is reducing infection transmission between infected and susceptible in a herd

Transmission has three steps – escape, environmental survival, and infection

Infectious agents get out and in many ways
For most “enterics,” the major transmission cycle is fecal-oral and fecal exposure is the major risk.

In general, minimize all sources of stress.

Stress plays a major role in Bovine Respiratory Disease (BRD).

Five steps lead to BRD occurrence:

1. Stress and upper respiratory ciliary damage
2. Growth of normal bacteria in upper airways
3. Failure of the mucociliary protection mechanism to clear the ventral lung (gravity)
4. Proliferation of normal nasal bacterial flora (Mannheimia hemolytica A1) out of place in ventral lung
5. Vicious cycle of infectious inflammation in the dependent ventral lung

Stress + virus + bacteria = BRD

BRD involves a wide range of infectious agents, some primary and many secondary:

**Bacteria**
- Mannheimia (Pasteurella) hemolytica A1
- Pasteurella multocida
- H. Somnus
- Mycoplasma spp.
- Salmonella spp.
- A. pyogenes
- Bacteroides spp.
- S. aureus
- Streptococcus spp.
- E. coli
- Melibiosa
- Chlamydia spp.
- Ureaplasma spp.

**Virus**
- BHV-1 (IBR)
- BRSV
- Puj
- BVD
- Adenonavirus
- BHV-4
- Rhinovirus
- Reovirus
- Enterovirus

**Parasite**
- Dictyocaulus viviparus
**Mannheimia hemolytica** is the most common BRD pathogen

Bacteria *Mannheimia (Pasteurella) hemolytica* serotype A1
- **Normal bacterial flora** in tonsillar crypts
- Spreads easily between calves
- Proliferates when:
  - Animal is stressed
  - Viral upper respiratory infection occurs
  - When certain feeds (silage) are fed

The mucociliary clearance mechanism removes particles from lungs

Based on Cilia waves:
- Moves mucous from respiratory tract to throat
  - swallowed
- Moves at 1.5 cm / min with 1,500 waves / min
- Clears 90% of bacteria in 4 hrs
- Damaged by infectious agents, dust and fumes
  - diesel smoke, ammonia, corral dust

Normal Cilia (Electron Micrograph)

Ciliary damage slows or stops the clearance mechanism

In BRD normal bacteria proliferate, move to lung, are not cleared, and cause inflammation

Bacteria are inhaled

Normal bacteria proliferate in Nasal Cavity

Bacteria release toxins, attracting WBCs

Lungs

BRD lung damage is due to a vicious cycle of inflammation

- *M. hemolytica* attracts white cells from bloodstream
- *M. hemolytica* grows in the accumulating tissue fluid
- *M. hemolytica* leukotoxin kills the white cells
- White cell components cause lung damage, releasing tissue fluid and attracting more white cells
- Animal’s natural response causes the lung damage!
Looking at the question another way

**Farm Level Reality** – Most diseases are endemic

<table>
<thead>
<tr>
<th>Non-Exposed Farms</th>
<th>Exposed Farms</th>
</tr>
</thead>
<tbody>
<tr>
<td>0!</td>
<td></td>
</tr>
</tbody>
</table>

The answer – the presence of risk factors in those herds

Production systems are dynamic relationships between animals, infectious agents, and their environments

When disease problems occur:
- After asking “What’s wrong?”, ask “How did the system get here?”
- Ask “What changed?”
  - A change in one point of the system often leads to unintended consequences elsewhere
- “A common error is to define the problem not by what’s happening in the system but by the lack of our favorite solution” (D Meadows)


A particular infectious dose results in differing severity in a herd

<table>
<thead>
<tr>
<th></th>
<th>Infected</th>
<th>Subclinical</th>
<th>Clinical</th>
<th>Unaffected or Recovered</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Goal: Reduce infectious dose, increase host resistance

Clinical disease doesn’t occur when resistance is high relative to exposure dose

Both vary over time and location as seasons change and animals move through the production cycle

Pattern of Host Resistance - Calves

<table>
<thead>
<tr>
<th>Host Resistance</th>
<th>Birth</th>
<th>Vaccination</th>
<th>Weaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stress</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calf Nutrition</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dystocia</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dam Nutrition</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bad Colostrum Mgmt!</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Pattern of Host Resistance - Cows

<table>
<thead>
<tr>
<th>Host Resistance</th>
<th>Nutrition</th>
<th>Transition Stress!</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Disease</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agent Exposure Dose</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disease!</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Most Infectious Diseases are **Opportunists**!

Note that there are more opportunists than there are vaccines!
Most vaccines provide marginal protection but not absolute protection

Clinical disease outbreaks result from a breakdown that initiates a vicious cycle

Focusing on a "bug" keeps us stuck in a rut!

On unoriginal thoughts:

Albert Einstein’s more relevant quotes:

On the other hand:

Albert Einstein's more relevant quotes:

On the other hand:
Focus on the entire husbandry system rather than individual diseases

The Animal Hosts

The Disease Agents

The Environment

(Housing, Nutrition, ...)

MANAGEMENT

Different diseases have common risk factors

Disease severity is determined by many factors

<table>
<thead>
<tr>
<th>Lower Severity</th>
<th>Higher Severity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower Dose</td>
<td>Higher Dose</td>
</tr>
<tr>
<td>Middle Aged</td>
<td>Neonate or Elderly</td>
</tr>
<tr>
<td>Lower Stress</td>
<td>Higher Stress</td>
</tr>
<tr>
<td>Adequate Cu, Se, Vitamins A, E</td>
<td>Deficient Cu, Se, Vitamins A or E</td>
</tr>
<tr>
<td>No other diseases</td>
<td>Other diseases, co-infections</td>
</tr>
<tr>
<td>Higher social dominance</td>
<td>Lower social dominance</td>
</tr>
<tr>
<td>Lower producing</td>
<td>Higher producing</td>
</tr>
<tr>
<td>Higher specific immunity</td>
<td>Lower specific immunity</td>
</tr>
</tbody>
</table>

Horizontal Transmission Chain

Infected Host

Sheds Agent in oral & nasal secretions, urine, feces

Contaminated Environment

Agents survives at Infectious Dose

Hands, Thermometers, Equipment, Feed, Water, Boots, ...

Susceptible Host

Becomes

Minimize infectious agent flow through all links of the transmission chain

Infected Host

Sheds Agent

Environment

(Hands, Housing, Food, Water,...)

Agent survives at Infectious Dose

• Isolate
• Reduce shedding level

Susceptible Host

• Remove contaminated materials
• Increase agent death rate
• Increase resistance
• Isolate to minimize infectious dose

This flow will occur almost inevitably if the agent isn’t present now but the risk factors are!

Herd "Hardening" is applying strategies that reduce dose and shift the curve

• Take advantage of increasing resistance with age
• Separate groups with high shedding risk from those with high acquiring risk
• Decrease survival opportunities of agents
• Attack all the agent transmission routes

The greatest weakness of most strategies is the failure to address all the transmission routes

Apply the general principles to the entire farm system

The neonatal calf is the most susceptible animal on most farms

• Maximize the calf’s natural resistance and acquired immunity
• Delay and minimize the infectious dose the calf is exposed to
  – Because these agents are ubiquitous, calf must eventually acquire the infection and develop an active immunity
Don't feed antibiotics unless for specific, short duration treatment!

- Not effective against viruses or protozoa
- Most scour-causing bacteria are resistant!
- Selects for more resistance
- Increases host susceptibility to other infections

Avoid antibiotics in milk replacer and starter!

Maximize passive transfer by monitoring it

Passive antibody level vs. scours

Number & Severity of Scour Episodes

Absorbed Passive Antibody Level

Anything you don't monitor you likely aren't doing as well as you could

Antibodies control bacteria

But only in the calf!

Handle colostrum like grade A milk for sale

- Disease-causing bacteria grow just as well in colostrum as in milk
- These bacteria are transferred with the colostrum into the blood stream
- Harvest into sanitized containers and refrigerate or freeze it if not used immediately
- Don’t pool!
  - BLV, Salmonella, and Johne's are transferred by colostrum

Disease risk can occur in unexpected ways

Colostrum cooling on the parlor floor (Remember the little black spots)

Anything wrong here?
Apply sufficient cleaning and sanitizing criteria

**General Rules:**
- **Look Clean**
- **Feel Clean**
- **Smell Clean**

If it doesn’t, it ain’t

**Agents die by exponential decay in the environment**

Agents die by exponential decay in the environment

**Time reduces exposure dose, reducing exposure consequences**

**Proper sanitation breaks the half-life curve**

**For sanitation success doing each cleaning and disinfection step is critical**

- **First Step** - Thorough rinsing and cleaning, whether hutch, hands, or nipples
- **Remove all** organic matter (feces, blood, milk, milk stone, milk fat, saliva)
  - Protects infectious agents from action of disinfectants (chemical or direct sunlight)
- **Soap, water, and scrubbing** are the most important; mechanically removing the agents

People often want to skip this step because of the “elbow grease” often involved

**Chemical disinfection requires an effective agent at concentration with full contact time**

- Use a disinfectant with labeled effectiveness against target agents
  - Many are not effective, such as Pinesol
  - Environmental surfaces – 1-stroke Environ
  - Tissue contact - Nolvasan or tamed iodine
  - General use - Virkon S
- Allow adequate contact time (temperature dependent) at sufficient concentration
  - Organic material (milk, manure) inactivates most disinfectants, especially chlorine-based
  - Chlorine begins evaporating when mixed

People often use a solution too long, use too little, and don’t allow sufficient contact time
VirkonS is one of the best overall disinfectants

- 1.3 ounces of Virkon S per gallon of water
- One gallon of solution treats 135 square feet
- ~$100 per 10 lbs

For more information, see CFSPH "Disinfection 101" at http://www.cfsph.iastate.edu/BRM/resources/Disinfectants/Disinfection101.pdf

The final step of full drying is **critical**!

- Some agents are not killed by disinfectants, only full drying
- Low levels of other agents will likely remain that can begin replicating later
  - Salmonella will grow on a wet board!

A common error is to leave the items in the final tank with the disinfectant, assuming they will be sterile when removed

When hands are not visibly soiled, alcohol-based rubs are more effective than soap and water

![Graph showing bacterial reduction over time for different hand sanitizers](image)

- Alcohol-based handrub (62% ethanol)
- Antimicrobial soap (4% Chlorhexidine)
- Plain soap


Principles for reducing pre-calving exposure - Beef

- Move cows and heifers to separate calving areas several weeks before calving
  - Skin and hair of cows on winter feed and bedding have infectious agents shed by carrier cows
  - Heifers generally have poorer colostrum
  - Heifers need more calving supervision
  - To avoid "sophomore slump", heifers should be bred to calve one month ahead of cows

Principles for reducing post-calving exposure - Beef

- 1 Day after calving, move pair to large pasture area to spread out
  - Exposed calf takes about **3 days** to begin shedding agent in large numbers
- If scours develops in a group, leave all of that group in place but turn out new pairs to a new pasture
  - Remember the **"Iceberg Principle:"** Many calves will be subclinical shedders!

Beef Calving System

"The Sandhills Calving System"
- Developed in Nebraska by Dr. David Smith and colleagues
  - http://www.rangebeefcow.com/powerplsmith.pps
Reducing post-calving exposure - Dairy

- Within first day, move calf to a cleaned individual hutch isolated from contact and air space of other calves
- Sanitize anything that contacts calf’s mouth prior to that contact (nipples, esophageal feeders, pill guns, hands)

Reducing post-calving exposure - Dairy

- After weaning from milk, group by age in progressively larger groups
  - 1 to 7 to 14 to 28
- **DO NOT** hold back calves on the basis of small size; these are often carrier animals that will infect younger groups
  - Group poor doers separately

The House Fly *Musca domestica*

- Mouth Parts
- Puparium (Pupal Case)
  - 1/3 of “fly spots” are regurgitation of previous meal

Flies transmit dangerous disease agents

- What do you suppose the calf ingests besides water when drinking?

Colostrum cooling on the parlor floor

- Don’t overlook the cycles of the vermin (flies, rodents, birds!)

Damp straw bedding is a fantastic fly incubator

- Parasitic wasp raisers grow their flies in damp straw!
Most of all, avoid PPM!

Bad Management overwhelms the Best Vaccine every time!

The Last Lecture:
Achieving your childhood Dreams
Randy Pausch

http://www.youtube.com/watch?v=ji5_MqicxSo