Five steps lead to BRD occurrence:

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

*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 (weaning, trucking, mixing)
  - Viral upper respiratory infection (IBR, PI3, . . .)
  - Certain feeds are fed (silage)

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
  - IBR, PI3 virus (commingled salebarn calves)
  - Ammonia (enclosed dairy calf barns)
  - corral dust, diesel smoke (weaned beef calves)
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

BRD lung damage is due to a vicious cycle of inflammation

Animal's natural response causes the lung damage!

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?

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

**Goal:** Separate the susceptible from the potential subclinical
The economic loss from subclinical disease is usually greater than 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!

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

Consider clinically affected animals Red Flags!
They indicate the presence of a serious herd problem
They are not the full extent of the problem

Reduce infection transmission between infected and susceptible in a herd

- Reproductive Ratio ($R_0$) is the number of secondary infections due to each infection
  - $>1$: Infection spreads
  - $=1$: Infection is stable
  - $<1$: Infection dies out
- Hard to reduce in intensive management
  - agents co-evolved and survived with hosts when they were extensive, free-ranging

Goal: Get $R_0$ less than 1 so agent disappears from herd

Infection transmission occurs in two forms

- Vertical transmission can occur:
  - During birth
  - Infected colostrum
  - Suckled milk

Infectious agents get out and in in many ways

Transmission has three attack points — escape, environmental survival, and infection

Mammalian Body from bug’s perspective

Multiple entry and exit portals!
Looking at the question another way

Farm Level Reality – Most diseases are endemic

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 to this point?"
- 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

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 - Cows

Most Infectious Diseases are Opportunists!

Note that there are more opportunists than there are vaccines!
Most vaccines provide marginal protection but not absolute protection. Stress events can overwhelm the best vaccine immunity.

Clinical disease outbreaks result from a breakdown that initiates a vicious cycle. Factors include:
- Less susceptible hosts now affected
- Higher exposure
- Higher shedding from clinical disease
- More susceptible hosts
- Lower shedding from subclinical infection
- Higher environmental contamination

Focus on the entire husbandry system rather than individual diseases. Key elements include:
- The Animal Hosts
- The Disease Agents
- The Environment (Housing, Nutrition, ...)
Block infectious agent flow through the transmission chain links at multiple control points

**Infected Host**
- Sheds Agent
- *Isolate* 
- *Reduce shedding level*

**Environment**
- (Hands, Housing, Food, Water...)
- Agent survives at Infectious Dose
- *Remove contaminated materials* 
- *Increase agent death rate*

**Susceptible Host**
- *Increase Resistance* 
- *Isolate to minimize infectious dose*

This flow will eventually occur 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

Know key characteristics of the prevalent infectious agents

Example - Corona & Rotoviral Diarrhea:
- Virus kills cells of intestinal villi, causing malabsorption diarrhea
  - Calf begins shedding $10^{11}$ virus per gram of feces 3 days after infection
  - Carrier cows continually shed low numbers of virus
  - Virus survives weeks in the environment
  - Vaccines available, labeled “aid in preventing”
  - Antibiotics are ineffective (virus)

3 Keys to Management

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

Handle colostrum and liquid calf feed 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 Johnes are transferred by colostrum
Colostrum cooling on the parlor floor
(Remember the little black spots)

Avoid food (or feed) temperature abuse
Minimize time liquid feed is between 140°F and 41°F after cooking (< 6 hrs)
• Thaw in refrigerator
• Rapid heating
• Rapid cooling
  – In freezer or refrigerator
  – In shallow pans
  – Sufficient air space

These practices apply to farm situations, such as colostrum management!

Low level Salmonella contamination is very common

Cross-Contamination?
Weather, misters?
Summertime, enclosed barn?

Low-level Salmonella Contamination
Most Foodstuff
Favorable Environmental Temperature
Sufficient Time
Replication

Infectious Dose!

Good food handling practices apply everywhere
Colostrum refrigerator on large farm

Colostrum was not cooling quickly, resulting in excessive bacterial counts

See anything wrong here?
When was the temperature last checked?
Appliances are often cast-offs from the house

Apply sufficient cleaning and sanitizing criteria

General Rules:
1. Look Clean
2. Feel Clean
3. Smell Clean

If it doesn’t, it ain’t

Agents die by exponential decay in the environment

Infectious Host Sheding Level
Number of Infective Particles
Agent shed into Environment

Half Life Curve

Time to ½ Level = Half Life

Time
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*

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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, chlorine dioxide
  - Tissue contact - Nolvasan or tamed iodine
  - General use - **Virkon S**
- Allow adequate contact time (temperature dependent) at sufficient concentration
  - Organic material (milk, manure, blood) inactivates most disinfectants, especially chlorine-based
  - Chlorine begins evaporating when mixed (detectable odor)

*People often use a solution too long, use too little, and don’t allow sufficient contact time*

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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
- ~$80 per 10 lbs
- Chlorine dioxide is an emerging disinfectant

*For more information, see CFSPH "Disinfection 101" at* [http://www.cfsph.iastate.edu/BHM/resources/Disinfectants/Disinfection101.pdf](http://www.cfsph.iastate.edu/BHM/resources/Disinfectants/Disinfection101.pdf)

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The final step of full drying is critical!

- Some agents are not killed by common 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 alcohol-based handrub, antimicrobial soap, and plain soap.]

Groups with effective hand sanitation programs had 50% as many respiratory and gastrointestinal episodes as others!

Most important is cleaning hands frequently and effectively

To wash hands:
- Wet hands (avoid HOT water – dries skin > cracking)
- Apply soap
- Rub hands together for at least 15 seconds
- Cover all hand surfaces
- Rinse with water and dry thoroughly
- Use a paper towel to turn off faucet

Why all the fuss about Hand Washing?

A most common mode of pathogen transmission is via hands!
- CDC estimates proper hand washing reduces foodborne illness by 50%
- Proper hand washing reduced respiratory illness 45%
- Infections acquired in dense settings (classrooms, offices, daycares)
- Infections acquired in healthcare

Proper hand washing is the single biggest weapon against transmission of common human infectious diseases

Basic Personal Hygiene for Humans

Although 92% of people say they washed their hands, only 56% of men and 88% of women do (www.washup.org)

The House Fly Musca domestica

Mouth Parts

½ of "fly spots" are regurgitation of previous meal

Puparium (Pupal Case)

Flies transmit dangerous disease agents

What do you suppose the calf ingests besides water when drinking?
Don't overlook the cycles of the vermin (flies, rodents, birds)

Colostrum cooling on the parlor floor

Dead Flies!

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!

General Livestock Food and Water Safety Rule

If you wouldn't eat off of it or drink out of it, don't expect a cow to either!