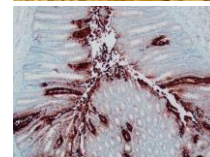


Calf Diarrhea: Rotavirus, Coronavirus & Cryptosporidiosis

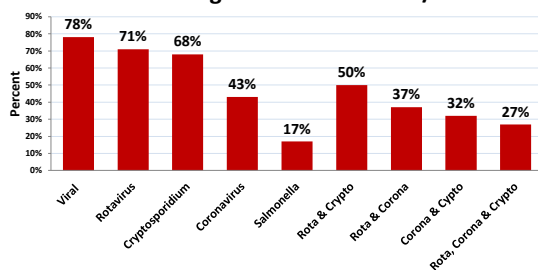
Jeremy Schefers, DVM, PhD
Minnesota Veterinary Diagnostic Laboratory, St. Paul, MN

These calves are fed 2 gallons of milk, have no cold stress, but they still scour...



Calf colon: Microscopic picture of Coronavirus infection

Percent pathogens in 343 fecal samples from scouring calves* on 12 large dairy farms during the winter of 2010/11



*More than 90% of these calves had total proteins >5.5 g/dL (adequate passive transfer)

Rotavirus, Coronavirus and Cryptosporidiosis - Similarities

- All are spread by the fecal oral route.
 - Calves eating feces, usually from **older calves**.
 - It's hard to find these bugs in adult cows & the maternity pen.
- None are bacteria and none are killed with antibiotics
 - Many producers use antibiotics for the secondary bacterial infections, but this practice is hotly debated.
- Feeding or IV's of electrolytes treats the dehydration, not the bug.
- Nothing in a veterinary clinic, or a vet's truck box, have been proven to directly kill these pathogens.
 - They do have vaccines to help PREVENT Rotavirus and Coronavirus by "asking" pregnant cows to produce antibodies passing the antibodies in the colostrum and transition milk.
 - Don't underestimate the significance of transition milk and passive "lactogenic" immunity

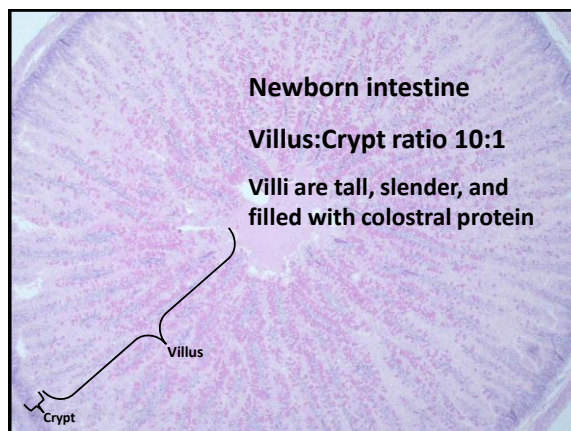
Rotavirus, Coronavirus and Cryptosporidiosis - Differences

- Antibodies (not antibiotics) are effective at controlling Rotavirus and Coronavirus, but not Crypto.
- Coronavirus is extremely fragile and is easily killed by heat, sunlight and most disinfectants.
- Rotavirus and Crypto are extremely tough and resistant to many, many detergents and disinfectants.
- Powerwashing does a good job of reducing environmental "load," but you it is difficult powerwash your way out of a rotavirus problem.

Newborn intestine

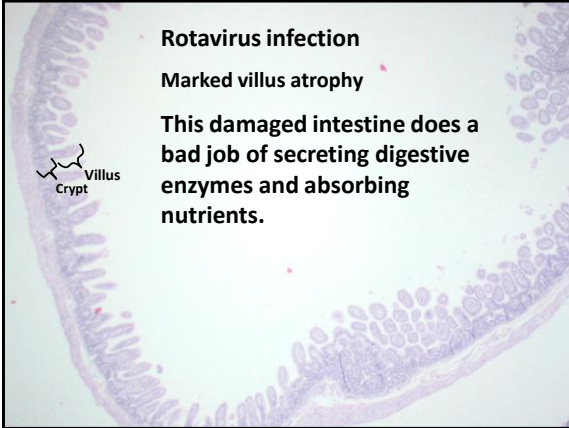
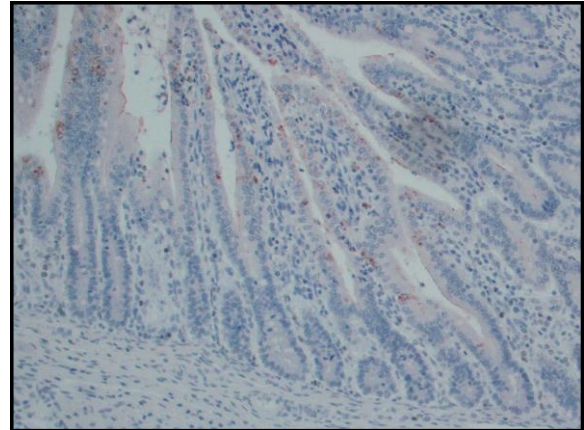
Villus:Crypt ratio 10:1

Villi are tall, slender, and filled with colostrum protein



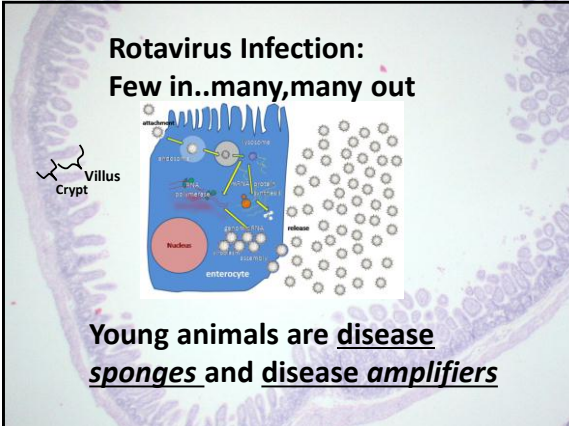
Rotavirus infection
Marked villus atrophy

This damaged intestine does a bad job of secreting digestive enzymes and absorbing nutrients.

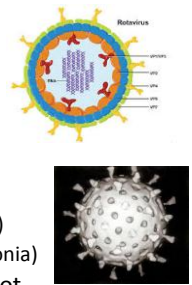
Rotavirus Infection:
Few in..many,many out

Young animals are disease sponges and disease amplifiers



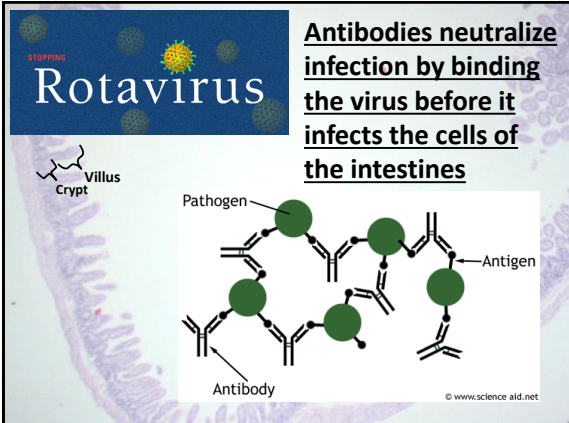
Unique Features of Rotavirus

- Rotavirus is...
 - Everywhere.
 - Resistant to most disinfectants
- Things that will inactivate rotavirus
 - A torch
 - A pH below 2 (battery acid, HCl)
 - A pH above 11 (lye, lime, ammonia)
- Eradication on a dairy farm is not practical and extremely unlikely



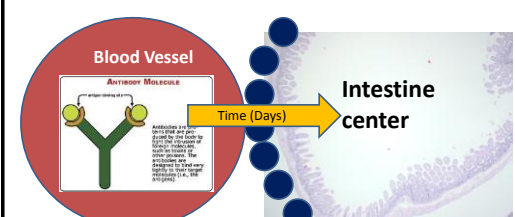
STOPPING Rotavirus

Antibodies neutralize infection by binding the virus before it infects the cells of the intestines



© www.science.aid.net

IgA antibodies that protect the "guts" need at least two weeks to develop



When born, the mechanism that produces and secretes antibodies is not running. It takes about 2 weeks to fully develop. Nearly all mammals are relying on antibodies in the milk for protection during the first two weeks.

Colostrum, transition & whole milk

Table 1. Typical analysis of colostrum, transitional milk and whole milk from Holsteins.

Component	Milking number			
	1	2	3	11
	Colostrum	Transitional milk	Whole milk	
Total solid, %	23.9	17.9	14.1	12.5
Fat, %	6.7	5.4	3.9	3.9
Protein, %	14.0	8.4	5.1	3.1
Antibodies, %	6.0	4.2	2.4	0.09
Lactose, %	2.7	3.9	4.4	4.9
Minerals, %	1.11	0.95	0.87	0.74
Vitamin A, ug/dL	295	190	113	34

Source: adapted from Folley and Otterby, 1978.

Colostrum in blood and intestines

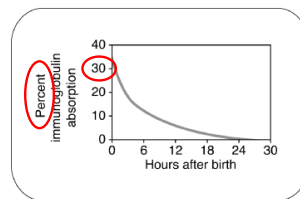
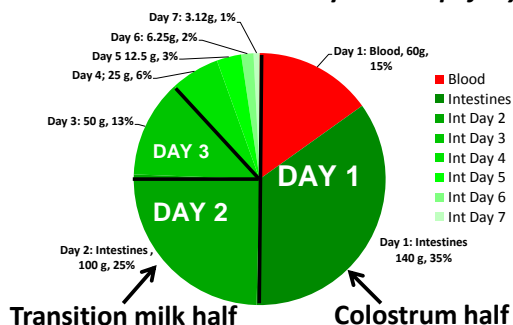


Figure 1. The ability of a calf to absorb immunoglobulins declines rapidly after birth.

- At best, **30% of the antibody goes into the blood.** The remaining **70% stays in the intestines** and some will still be found out to 5 days...that's not necessarily a bad thing.

The 1 pound antibody "pie" produced by the cow and consumed by calf...*hopefully*



The Antibody Pie – Dairy calves

- Total pie = 400 grams.
 - 200 grams is consumed on day 1
 - If the calf is switched to milk replacer or whole milk, it doesn't get the other half of the pie.



2010 Rotavirus Research

Veterinary Immunology and Immunopathology 136 (2010) 12–27



Research paper

Milk supplemented with immune colostrum: Protection against rotavirus diarrhea and modulatory effect on the systemic and mucosal antibody responses in calves experimentally challenged with bovine rotavirus

V. Parreño^{a,*}, C. Marcopido^a, C. Vega^a, L. Garaiocoechea^a, D. Rodríguez^a, L. Saif^b, F. Fernández^a

^a Instituto de Virología, CICV y A-INIA, CC 25 1712 Casador, B. As. Argentina
^b Food Animal Health Research Program (FAHRP), The Ohio Agricultural Research and Development Center, The Ohio State University, USA

Table 2 Diarrhea and fecal virus shedding in calves after oral inoculation with BRV ND (P19)G1.

Treatment groups	n	Inoculum infectious titer (PFU/ml)	Virus shedding ^a							Days with fever (>39 °C)	
			% affected calves ^b	Mean onset (SD)	Mean duration (days)	Mean cumulative score ^c	% affected calves ^b	Mean onset (SD)	Mean peak shed virus (CCPF)		Mean RV titer (CCPF)
Gp 1: CC + IgG ₁ 4096 milk	10	10 ^{10.64}	20% ^a	4 ^{ab}	1.3 ^c	2.6 ^c	60% ^a	6.67 ^a	1.6 ^b	10 ^{7.5} ^a	0.8 ^a
Gp 2: CC + IgG ₁ 1024 milk	8	10 ^{10.15}	62.5% ^{ab}	5.2 ^b	3.88 ^{bc}	10.25 ^{bc}	100% ^a	4.5 ^b	5.88 ^b	10 ^{7.2} ^{ab}	3.7 ^{ab}
Gp 3: CC + Ab-free milk	8	10 ^{10.44}	100% ^a	2.4 ^a	7 ^{ab}	19.3 ^{ab}	100% ^a	2.15 ^a	7.88 ^b	10 ^{7.5} ^a	6.87 ^a
Gp 4: CD + Ab-free milk	5	10 ^{10.9}	100% ^a	1.2	10.8 ^a	29 ^a	100% ^a	1.6 ^a	5.4 ^a	10 ^{7.4} ^a	5.6 ^a

Ab supplemented calves were less likely to scour.

When they did scour...

- ...they scoured for fewer days,
- ...shed less virus, &
- ...had fewer days with a fever.

BUT...It's not practical to feed dairy calves the 2nd, 3rd, 4th, 5th, etc. milk from each dam!?

Any extra colostrum can be frozen, saved & fed. Colostrum has the highest concentration of antibody. Transition milk is also good.



Top 10 reasons this doesn't happen

10. I should NOT have to do this.

- The cow is making these antibodies for a reason. Don't "buck" mother nature. Mom knows best.

9. I don't have any extra colostrum.

- Fair excuse, use the 2nd and 3rd milk (transition milk)

8. The calves still scour.

- Check for Crypto. Antibodies won't help Crypto.
- If the dry cows were not vaccinated with a rotavirus or coronavirus vaccine, they won't have the right antibodies

7. Can't I just use colostrum replacer?

- No. Odds are that the colostrum replacer doesn't have enough antibodies specific toward rotavirus.

6. Can't I just buy some antibodies in a bottle?

- No. If I could make synthetic antibodies in a lab, I would do it all day, every day and become filthy rich.

5. My vet tells me the antibodies don't get into the blood.

- Your vet is right, the antibodies don't get into the blood, but the infection is in the intestines, not the blood stream.

4. I put the transition milk in the tank.

- So, you would rather sell a few pounds of transition milk, then turn around and buy things to treat calf diarrhea? The antibodies have much more value in the calf intestines than they do in a block of cheese.
- A gallon of colostrum has a value of about \$60 to the calf, a gallon of transition milk has about a value of \$30 to the calf.

3. Should I pasteurize the colostrum / transition milk?

- Only if it's contaminated. High temp pasteurizing will destroy some antibodies. 141 F for one hour preserves antibodies.

2. My calves don't scour, should I do it?

- If it's not broke, then don't fix it.
- Many farms that feed pasteurized waste milk, including transition milk, have minimal problems.

1. What about Johne's disease?

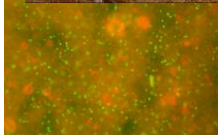
- Feeding raw colostrum from a Johne's cow to young calves is a risk.
- Both the initial colostrum feeding and any subsequent milk from positive cows should not be fed to young calves.
- Colostrum & transition milk from negative cows is good.

Cryptosporidiosis

- 25% of calves were dying and they were LOADED with Crypto.
- Crypto is spread by calves eating feces.
- Where are these calves getting Crypto??



Crypto (green dots) as highlighted by Fluorescent Antibodies (IFA)



The panels



Crypto is a cleaning problem

- The hutches were power-washed and placed on "clean" ground.
- Newborn calves were put in clean hutches, but the cattle panels remained dirty between calves.
- Feces were removed from the panels with a hand brush and an inexpensive soap.
- Mortalities (dead) calves dropped to 1%, but many still had diarrhea.

Another Crypto case

- After a long winter of not cleaning, all calves scoured and high levels of Crypto were detected.
- The manure was hauled, the stalls were washed.
- After powerwashing, the entire area was rinsed with a low pressure rinse to move the Crypto that has splattered on "clean" surfaces
- Crypto cases stopped with cleaning alone.



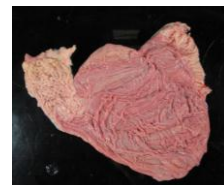
Scouring calves were fed electrolytes. No Crypto "treatments" were attempted.

Rota, Corona and Crypto

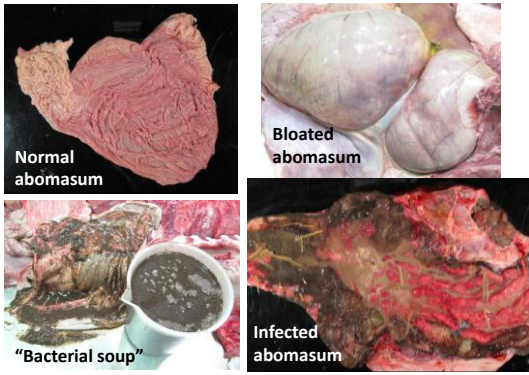
- Rotavirus and coronavirus infections are well-controlled by focusing on immunity.
 - Vaccinate the cow, feed the colostrum and the transition milk to the calves. Transition milk or colostrum cubes have to be fed for about 2 weeks. At about 2 weeks, their gut will be making their own antibodies.
- Crypto is a cleaning problem.
 - **Cleaning procedures matters!**
 - Remove manure and bedding
 - Powerwash what the fork missed. Powerwashers loosen the manure, but then blow it up into the air and rotavirus and crypto settle on the stuff you just cleaned.
 - **THE FINAL STEP OF CLEANING SHOULD BE A LOW PRESSURE RINSE COVERING THE ENTIRE ENVIRONMENT, WHICH INCLUDES THE PANELS, WALLS, PAILS AND ANYTHING ELSE THE CALF CHEWS ON.**

Unique features of calf stomach (abomasum) and intestines

- Their abomasums do NOT produce high levels of hydrochloric acid needed to kill (or greatly reduce) ingested pathogens.
- Calves can not vomit.
- The abomasum is expecting to "see" clean milk, and not high levels of bacteria.



Abomasitis: 7-day-old calf found dead



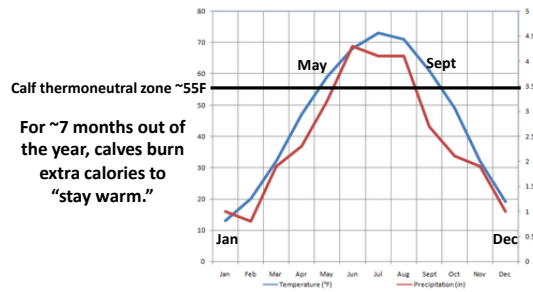
What to do??...Consult the List

One, or more, are potential causes...

1. Contaminated colostrum and/or milk (*Bacterial soup*)
2. Improperly mixed (hyperconcentrated) milk replacer
3. Free-choice water availability problems.
4. Improperly mixed (hyperconcentrated) electrolytes
5. Excessive oral supplements, probiotics, & antibiotics
6. Pasteurization problems. Heat damaged or failed.
7. Poorly digestible, plant-based milk replacers
8. Excessive bedding consumption

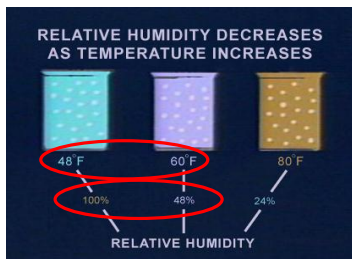
Calf health: Weather and the environment in which they live.

Average Monthly Temperature & Precipitation in Minneapolis, MN.



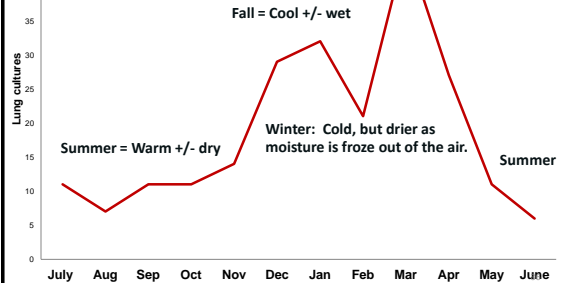
COOL AIR (↑ 32° F) IS WET, HUMID AIR
 MOISTURE ACCELERATES CHILLING & HEALTH PROBLEMS.
COLD AIR (↓ 32° F) IS DRY AIR (WATER IS "FROZE OUT")

Simply warming the air 12° F (from 48 to 60° F) drops the humidity more than 50%.



Mannheimia hemolytica pneumonia (by month)

Cattle have a tough time transitioning into, and out of, winter. Cool & wet environment is a driver



Cool air is often wet air, but **COLD AIR** is *dehydrating*

(Dr Brickman U of Toledo Medical Center)

- In cold weather, humans lose **3-4 liters** of water per day by humidifying inhaled cold, dry air.
- Exhaled moisture is **froze & falls** to the ground (or freezes to beard)
- In humans, **1500 – 2000 calories** are lost by warming cold, dry air.
- If not replaced, dehydration will cause a lower blood volume leading to **more hypothermia**.
- In cold weather, **physical activity** is needed to avoid hypothermia in humans and may require up to 6000 total calories (about 3X basal rate).



Calves and **cold**

- During the coldest months of the year, calves may have to be fed twice as much to compensate for cold losses.
- **Cool** air is often humid air.
 - Moisture & humidity chills calves
 - Chilled calves get sick...usually pneumonia.
- **Cold** air is dehydrating
 - In cold temperatures, water consumption has to increase to compensate for the moisture lost during breathing.

The **COLD** effect

Humans extrapolated to calves

Mammal = Human (200 lbs.) **Mammal: Calf (100 lbs.)**

- | | |
|---|--|
| • 3-4 liters of additional water loss from breathing | • 1.5 – 2 liters of additional water loss |
| • 1,500 – 2000 more calories “burned” to keep warm | • 750 – 1000 more calories burned to keep warm |
| • Physical muscle activity is needed to generate the heat | • Unless the calf hutch has a treadmill, there is no physical activity |

Off-setting cold with calories

- **There is NO DOUBT**
 - That calves fed more milk will grow faster.
 - That a calf that is satisfied (or full) of milk has a reduced incentive to eat starter grain.
 - That starter (grain) consumption is needed for rumen development.
 - That **weaned** Holstein calves need to eat more than 1% of body weight (2 lbs) and quickly move up to 3% (6 lbs) of body weight to maintain a positive energy balance.
- **BUT**, just because a calf eats a lot doesn't mean it won't get sick.
- Where is the **“sweet spot”** of balancing milk and starter intake / rumen development?....**it depends.**

How much milk should be fed?

- It could range between 50 total lbs. over 6 weeks to 100 total lbs. over 9 weeks for the same calf.
- Many would argue 2 quarts twice a day for 6 weeks (50 total lbs) is “starving” the calf, but it's heavily dependent on housing.

“Low rate” 50 total pounds ~ 6 wks



- These Holstein calves are fed 2 quarts of cow's milk twice a day for 6-7 weeks.
- The don't scour, they don't get cold and the don't get too hot.
- They are housed on straw in a dairy barn at ~50° F.
- They begin eating starter and drinking water by 10 days.
- If they are fed more milk, it slows starter intake & delays weaning.
- They ALL double their weight in 2 months and grow up to make 30,000 lbs. milk.
- Morbidity (sick) and mortality (dead) calves are both less than 1%.

“High Rate:” 100 lbs. over 9 wks

- Calves born Jan 1
- Average temp 5° F
- They all scour, 5% die
- For every degree below 55° F, 1% more MR was fed to compensate for heat loss.
- Milk replacer calculation:
 - Baseline 50 lbs
 - Heat loss 25 lbs
 - Scour loss ~10 lbs.
 - Delayed wean due to cold ~15 lbs.



These calves doubled their weight in 2 months and grew up to milk 30,000 lbs, but it took more milk replacer and it had to be fed longer to off-set cold and scour losses.

TOTAL MR: 100 lbs.

Conserving heat by “nesting”

- Deep straw insulates around the calf.
- Legs should be buried in bedding.
- Calf jackets can be added in November through March.
- The calf, the bedding and the floor **HAS TO BE DRY**.
- Frequent bedding is need to maintain the “fluff.”
- Feeding twice as much milk will produce twice as much urine and feces.
- To make this work, producers have said they need 2X bedding



Hypothetical bedding calculation for 8 weeks:

- **Moisture added:**
 - 860 lbs of water from MR
 - 200 lbs of water from free choice water
 - 1060 lbs of total water
- **Straw bedding absorbs ~4X weight in water**
 - **265 lbs. of dry straw** to absorb the water added to grow the calf over 8 weeks.

Sunshine matters

It's **20 degrees colder** in the shade (visitor's side line)...
...than the Gophers side.



Barn design

- #1: Faces south to capture sunshine providing light, warmth, drying and UV light
- #2: Plywood prevents snow from blowing in & “drafting”
- #3: Bedding keeps calves dry and getting wet from the bottom up.
- #4: Calves eat clean bedding promoting rumen development
- #5: Barn is about 40 feet wide allowing for natural ventilation.



46

Failing to control blowing snow



**Failing to control blowing snow:
Snow melts on their backs, saturates bedding = chilling = disease.**



“Warm Barns” for calves

In veterinary school, I was taught that warm barns are where calves go to die. One professor described it as a “calf coffin” and all calves will have lung damage. Yet pigs and poultry thrive in a similar barn?



This producer fills this barn with bull calves from WI. The barn was built in 1976 & ventilated according to engineer specs. It is heated to 55F. Morbidity= 5% Mortality is < 1%. His propane bill is about \$7 / calf.



A few notes on heat...

- Heat production of various objects..

– 100 lb. calf	80-100 BTU/hr
– Various candles	100-300 BTU/hr
– 100 watt light bulb	350 BTU/hr
– 2,000 lb. cow	1,600+ BTU/hr
– A gallon of propane	90,000 BTU
- Mature, one ton cows can more than 20X more heat than a 100 lb. calf.
- Most heat produced by livestock is “wet, high moisture” heat that needs to be exhausted.
 - “It’s not the heat, it’s the humidity”

Problems unique to dairy calves

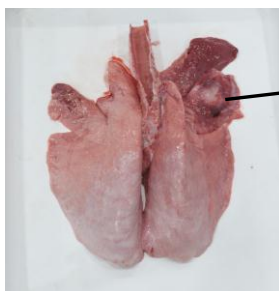
Esophageal feeding tube trauma



Rough balls on the end of a tube cut the esophagus and created a narrowing. The scar tissue obstructs flow and is a permanent lesion.

If you wouldn't slide the ball of a feeding tube BETWEEN your butt cheeks, don't slide it down the throat of a calf.

Aspiration pneumonia = Unilateral (right side only) consolidation



This is lung from a 2-month-old Holstein dairy calf. For reasons I can't fully explain, about 1/3 of calves develop this lesion after being tube fed colostrum. Affected calves develop a fever between 8 - 10 days of age. Treatment was unrewarding. Unfortunately, the abscess is permanent.

Pails and the rule of 24"

Most Holstein calves can only reach up to 24"



The height (21) + depth of pail (9) = 30 in.
Broke the rule of 24 by 6 inches.

These young calves don't eat starter or drink water because they can't reach it.



Consider using a shallow bowl instead of the deep pail for young calves (2-3 weeks).

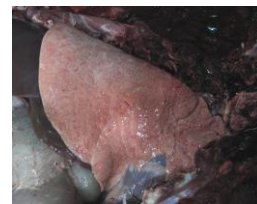
Excessive sorting & fines = erratic intakes = more pneumonia



Feeding for a healthy gut.
Feed texture matters



Healthy gut = Healthy lung
Coincidence??



Diseased gut = Diseased lungs
Coincidence? Which came first?



Summary

- Raising calves in this region is not easy.
- Lactating cows make **transition milk** for a reason....**FEED IT for the first week or two.** It will slow rotavirus and coronavirus scours if the dams were vaccinated.
- Crypto is a cleaning problem. A low pressure rinse should be the final step of washing.
- Wide swings in weather create a long list of challenges. Too hot, too cold, too wet, or some combination thereof.
- Avoid nutritional tunnel vision. Starter consumption is as important as milk consumption. If calves are not eating 3% of body weight within a week of weaning, investigation is needed.