




Wisconsin Veterinary Diagnostic Laboratory

UNIVERSITY OF WISCONSIN–MADISON

Reducing the Prevalence of Enteric and Respiratory Disease in Dairy Calves

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Diplomate ACVIM

Wisconsin Veterinary Diagnostic Laboratory

University of Wisconsin-Madison

Industry Standards

Separate calf from dam within 10-15 minutes of birth

Colostrum (quality, quantity, timing)

Brix refractometer: Colostrum Quality

Minimize FPT (75% ≥ 5.8 g/dL)

Proper disinfection of umbilicus

Calves kept dry and comfortable

Minimize cold and heat stress

Minimum 15 - 20 cm. of a **dry** bedding pack

Industry Standards

Feed 7.5-11.5 liters of milk or equivalent (1.0 -1.5 kg) milk replacer/hd/day.

Consistent diet (Less than 1% variation in % TS)

Adequate space (3.25 -4.25 sq. meters) (spatial density)

10-15 % calf pens empty (temporal density)

Calf Scour Vaccines

Efficacy Calf Scour Vaccines

Agent	Frequency %	Protect Infection	Protect Scours	Age of Onset	Incubation Days
K99 *E. coli*	≤ 2%	YES	YES	1 - 4	0.5 - 1
Attaching and Effacing *E. coli*	5-10%	NO	NO	3 - 14	1 - 3
Rotavirus	50 – 60%	NO	YES (40-60%)	5 - 17	1 - 3
Coronavirus	20– 40%	NO	YES (40-60%)	5 - 21	1 - 3
Cryptosporidium parvum	30 –60%	NO	NO	5 - 14	4 - 8
Salmonella spp.	10-20%	NO	NO	≥ 3 days	1 - 3

Human Cost of Scours

Number Calves Born/ Week	Scours Prev %	Scours Duration Days	Weaning Age Weeks	# Calves Requiring Electrolyte Each Day	% Calves Requiring Electrolytes Each Day	% Calves Requiring Electrolytes Each Day ≤ 21days
10	5%	4	8	2	2.5%	6.7%
10	10%	4	8	4	5.0%	13.3%
10	15%	4	8	6	7.5%	20.0%
10	20%	4	8	8	10%	26.7%
10	25%	4	8	10	12.5%	33.3%
10	30%	4	8	12	15%	40.0%
10	40%	4	8	16	20%	53.3%
10	50%	4	8	20	25%	66.7%
10	60%	4	8	24	30%	80.0%

Calf Scours: Current Status

20-25% of U.S. dairy calves develop diarrhea that requires oral electrolyte therapy before the calf reaches 21 days of age

Industry Standards: Best Practices

- Lower Mortality (Salmonella*)
- Reduce severity and duration of diarrhea
- Roughly 50% of the time no effect on morbidity!!

Why?

Not controlling pathogen load in calf environment

Summary

- Salmonella is an emerging problem in the dairy industry
- Once established: Environment and fomites reservoir of new infections for livestock
- Non-sanitary design huge problem particularly for critical control points (close-up pens, calving pens, sick pens, neonatal calf feed mixing rooms and calf rearing areas)
- Lack of industry knowledge on proper C&D and how to verify in real time that proper cleaning has been done

Summary

- Salmonella vaccines have an efficacy of 25-50%
- Do not provide protection from infection or prevent fecal shedding
- Not all Salmonella behave the same
- Salmonella isolates must be serotyped
- Most dangerous are *Salmonella* Newport, Dublin, 4,[5],12: i-, Heidelberg, Panama & Schwarzengrund

MAJOR ARTICLE

Salmonellosis Outcomes Differ Substantially by Serotype

Timothy F. Jones,[1] L. Amanda Ingram,[1] Paul R. Cieslak,[2] Duc J. Vugia,[3] Melissa Tobin-D'Angelo,[4] Sharon Hurd,[6] Carlota Medus,[7] Alicia Cronquist,[8] and Frederick J. Angulo[5]

[1]Tennessee Department of Health, Nashville; [2]Oregon Department of Human Services, Portland; [3]California Department of Public Health, Richmond; [4]Georgia Division of Public Health and [5]Centers for Disease Control and Prevention, Atlanta; [6]Connecticut Emerging Infections Program, New Haven; [7]Minnesota Department of Health, Minneapolis; [8]Colorado Department of Public Health and Environment, Denver

Background. Most human infections are caused by closely related serotypes within 1 species of *Salmonella*. Few data are available on differences in severity of disease among common serotypes.

Methods. We examined data from all cases of *Salmonella* infection in FoodNet states during 1996–2006. Data included serotype, specimen source, hospitalization, and outcome.

Results. Among 46,639 cases, 687 serotypes were identified. Overall, 41,624 isolates (89%) were from stool specimens, 2524 (5%) were from blood, and 1669 (4%) were from urine; 10,393 (22%) cases required hospitalization, and death occurred in 219 (0.5%). The case fatality rate for *S.* Newport (0.3%) was significantly lower than for Typhimurium (0.6%); Dublin (3.0%) was higher. With respect to invasive disease, 13 serotypes had a significantly higher proportion than Typhimurium (6%), including Enteritidis (7%), Heidelberg (13%), Choleraesuis (57%), and Dublin (64%); 13 serotypes were significantly less likely to be invasive. Twelve serotypes, including Enteritidis (21%) and Javiana (21%), were less likely to cause hospitalization than Typhimurium (24%); Choleraesuis (60%) was significantly more so.

Conclusions. *Salmonella* serotypes are closely related genetically yet differ significantly in their pathogenic potentials. Understanding the mechanisms responsible for this may be key to a more general understanding of the invasiveness of intestinal bacterial infections.

Source: Journal Infect Dis 2008: 198; pp109-114

Salmonella Concepts

- Not all Salmonella behave the same
- Invasive strains quickly translocate from intestine to systemic circulation
- Infectious dose required to cause disease is 1,000-10,000 times lower than for non-invasive strains of Salmonella
- Exacerbated with stress (heat, cold, transport, inconsistent diet (time) and improper weaning practices
- Three tiers of Salmonella

Tier 1: Non-invasive* (Cerro)

Tier 2: Mildly- moderately invasive* (Typhimurium, Montevideo)

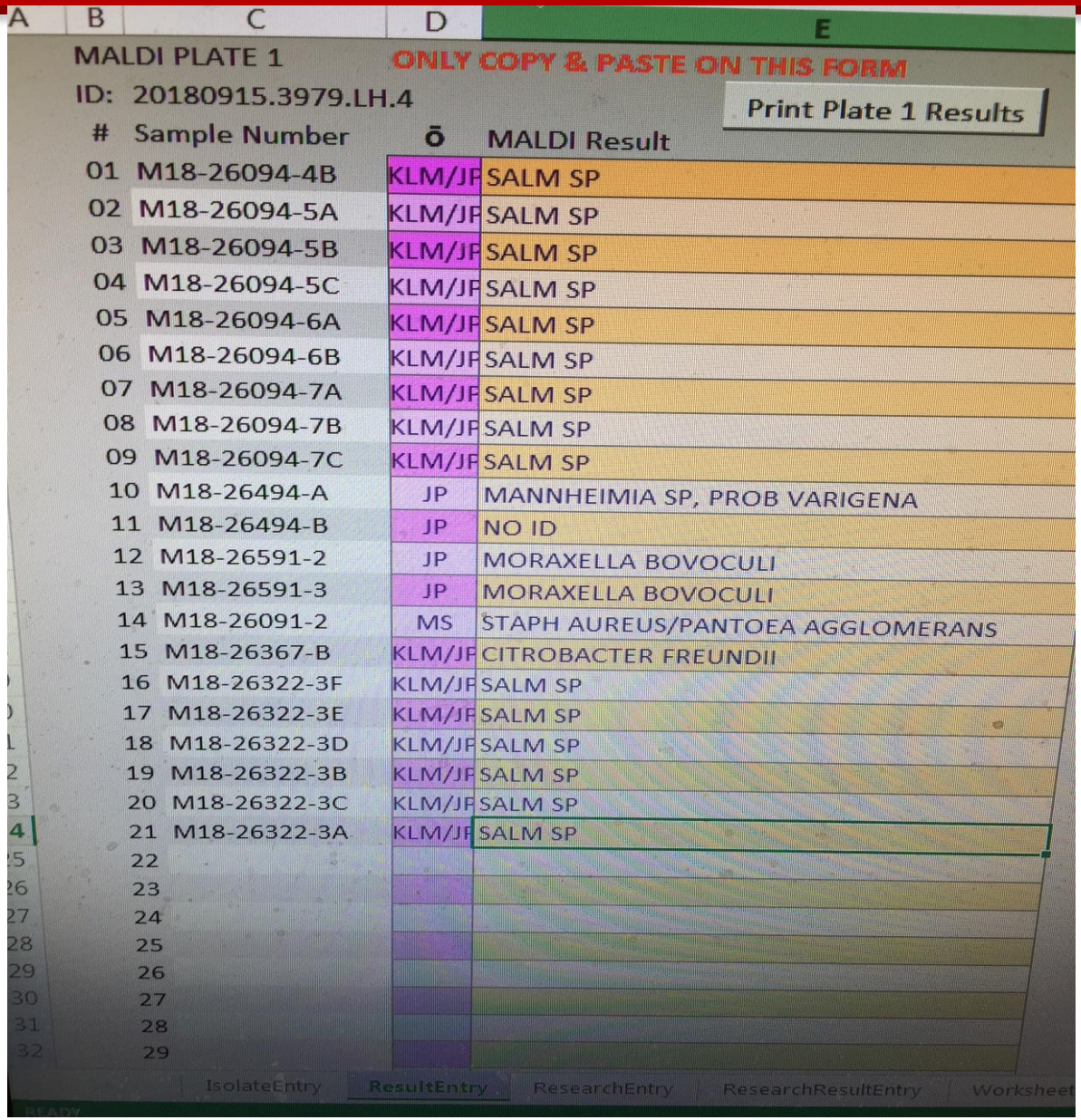
Tier 3: Highly invasive** (Panama, Dublin etc.,)

* Current best practices for dairy industry highly effective

**Current best practices for dairy industry NOT EFFECTIVE

Summary

- High iron in potable drinking water (≥ 1.0 ppm) cannot control Salmonella in preweaned calves
- Contaminated boots (fomites) major vector in Salmonella transmission
- Probiotics should be used for neonatal calves that have a high-risk of Salmonellosis
- Salmonella is a zoonotic disease. Importance of proper hand washing



MALDI PLATE 1 — ONLY COPY & PASTE ON THIS FORM

ID: 20180915.3979.LH.4

Print Plate 1 Results

#	Sample Number	ō	MALDI Result
01	M18-26094-4B	KLM/JP	SALM SP
02	M18-26094-5A	KLM/JP	SALM SP
03	M18-26094-5B	KLM/JP	SALM SP
04	M18-26094-5C	KLM/JP	SALM SP
05	M18-26094-6A	KLM/JP	SALM SP
06	M18-26094-6B	KLM/JP	SALM SP
07	M18-26094-7A	KLM/JP	SALM SP
08	M18-26094-7B	KLM/JP	SALM SP
09	M18-26094-7C	KLM/JP	SALM SP
10	M18-26494-A	JP	MANNHEIMIA SP, PROB VARIGENA
11	M18-26494-B	JP	NO ID
12	M18-26591-2	JP	MORAXELLA BOVOCULI
13	M18-26591-3	JP	MORAXELLA BOVOCULI
14	M18-26091-2	MS	STAPH AUREUS/PANTOEA AGGLOMERANS
15	M18-26367-B	KLM/JP	CITROBACTER FREUNDII
16	M18-26322-3F	KLM/JP	SALM SP
17	M18-26322-3E	KLM/JP	SALM SP
18	M18-26322-3D	KLM/JP	SALM SP
19	M18-26322-3B	KLM/JP	SALM SP
20	M18-26322-3C	KLM/JP	SALM SP
21	M18-26322-3A	KLM/JP	SALM SP
22			
23			
24			
25			
26			
27			
28			
29			

IsolateEntry | ResultEntry | ResearchEntry | ResearchResultEntry | Worksheet

Why is Dairy Calf Respiratory Disease Important?

Bovine Lung: Relatively small when compared to other mammals (horses, dogs, cats, goats and humans)

Cattle have less ability to "compensate" for decreased lung capacity than other mammals

Pneumonic lesions: Persist throughout the calf's growth and development and often get larger over time

Sequelae dairy calf pneumonia:

- decreased body size
- decreased reproductive performance
- decreased milk production
- decreased longevity in the herd

	Lung Volume Liters	Percent Basal Use	Pulmonary Air Flow Rate ml/min/ml	Oxygen Consumption L/min	Oxygen Consumption/ Liter of Lung
Cow	12.4	29.0	8.71	124.95	10.08
Horse	52.9	14.3	1.57	62.25	1.18

Comparison Horse vs. Cow*
Weight: 1078 lbs.

*Source: Veit HP, Farrell RL. 1978: The anatomy and physiology of the bovine respiratory system relating to pulmonary disease Cornell Vet 68: 555-581


Nesting score = 3
Legs generally not visible when lying down

Ventilation

Minimum: 4 Air Changes per Hour in Winter

Technical specifications of the systems

Positive Pressure Tube Calculator, Version 6.0

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School of Veterinary Medicine, University of Wisconsin-Madison
and Jakob Neumayer, Technical University of Graz, Austria
May 22, 2014

Dairyland Initiative
UNIVERSITY OF WISCONSIN-MADISON

Consultant:
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School of Veterinary Medicine
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Madison, WI 53706
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Project ID

Name:	Cole Apple
Barn ID:	Calf Barn-Parallel Tubes Along Each Side
Date:	7/28/2014

Dimensions of barn

Length	105 ft
Width	56 ft
Minimal interior ht	12 ft
Maximum interior ht	19 ft
Interior volume of barn	98,280 ft³
Maximum # of animals	80 head

Tube specifications & height

Length of tube	102 ft
Diameter of tube	22 in
Provided tube air speed	1,148 ft/m
Length/diameter ratio	56
Height, bottom of tube	11.0 ft

Air speeds

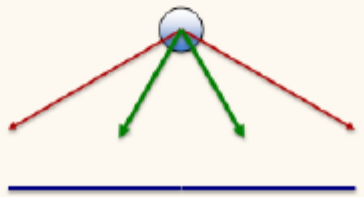
Target air speed	60 ft/m
Overall speed from holes	1,175 ft/m
Effective discharge speed	1,658 ft/m

Fan sizing and selection

Minimal ft³/m per animal	25 ft³/m
Total dm based on animal #	2,000 ft³/m
Volume of barn/animal	1229 ft³/animal
Target air changes per hour	4 changes/hr
Total dm based upon changes/hour	6,886 ft³/m
Estimated fan dm at 0.18" H_2O	3,030 ft³/m per fan
# of these fans used in the space	2 fan(s)
Total dm from all tube fans	6,060 ft³/m
Expected air changes per hour	4.0 changes/hr

Aperture ratio, discharge coefficient, and static pressure

Area, one "set" of holes	8.7 in²
Number of "sets" of holes	42 sets
Aperture ratio (a*n/A)	1.0
Discharge Coefficient $C_{orifice}$	0.65
Static Pressure	0.17 "H_2O



Spacing of perforated holes

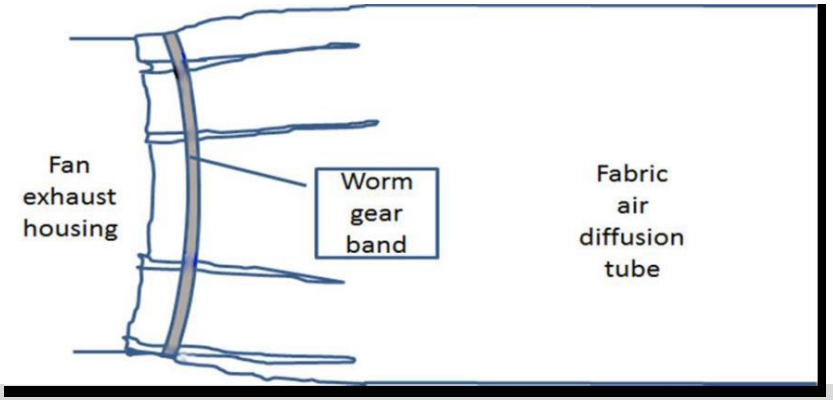
Hole intervals	29 in

Diameter of holes

Row 1, hole diameter	2.00 in
Row 2, hole diameter	2.00 in
Row 3, hole diameter	1.25 in
Row 4, hole diameter	1.25 in

Clock position of Holes	Expected throw distance to target air speed: Trajectory distance to target speed, ft	Horizontal distance to target speed, ft	Height at target speed above floor, ft	Comments:
4:00 Middle-right	14	12	4.1	
8:00 Middle-left	14	12	4.1	
5:00 Outside-right	9	4	3.5	
7:00 Outside-left	9	4	3.5	

Positive Pressure Air Tubes



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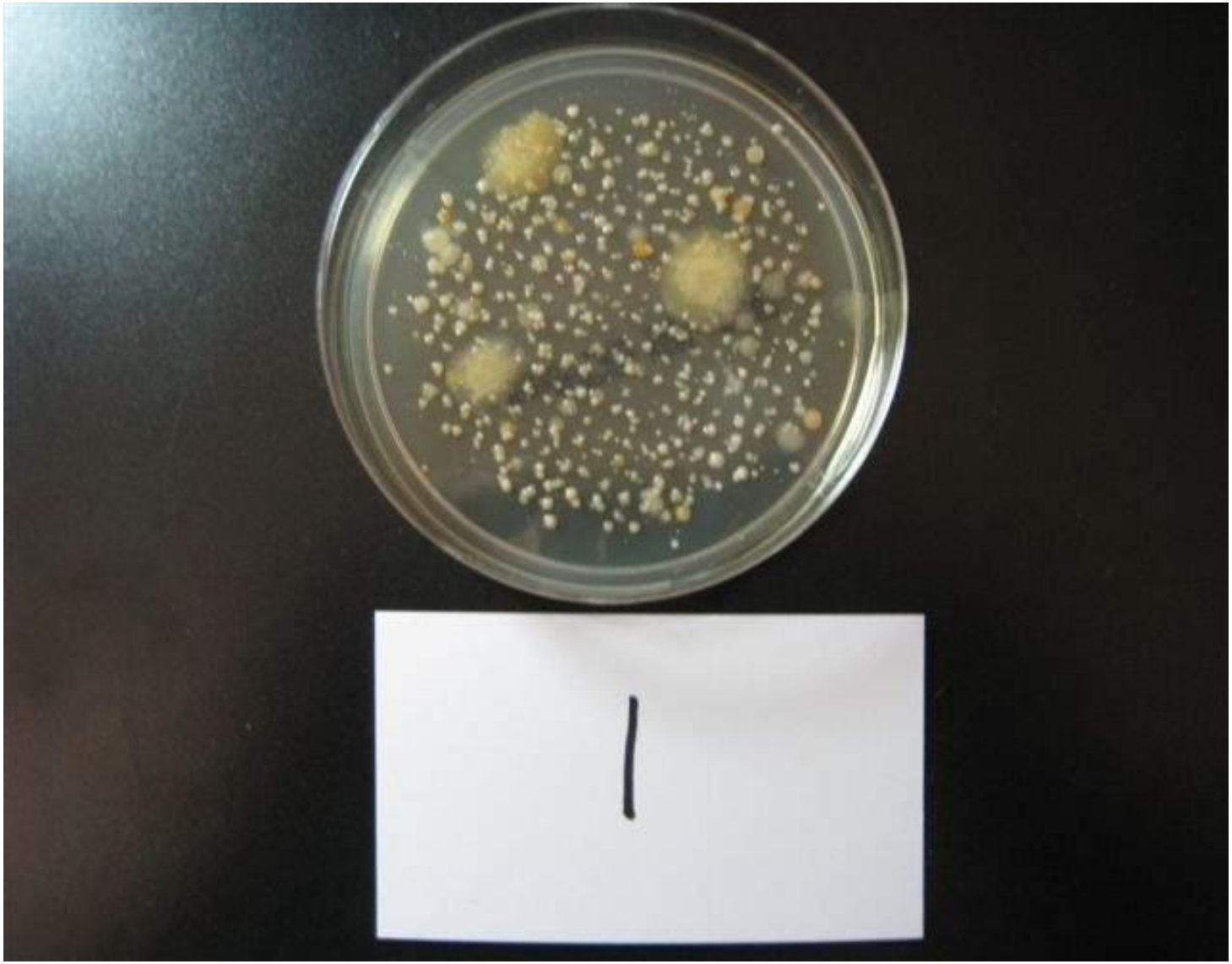
Outside
AIR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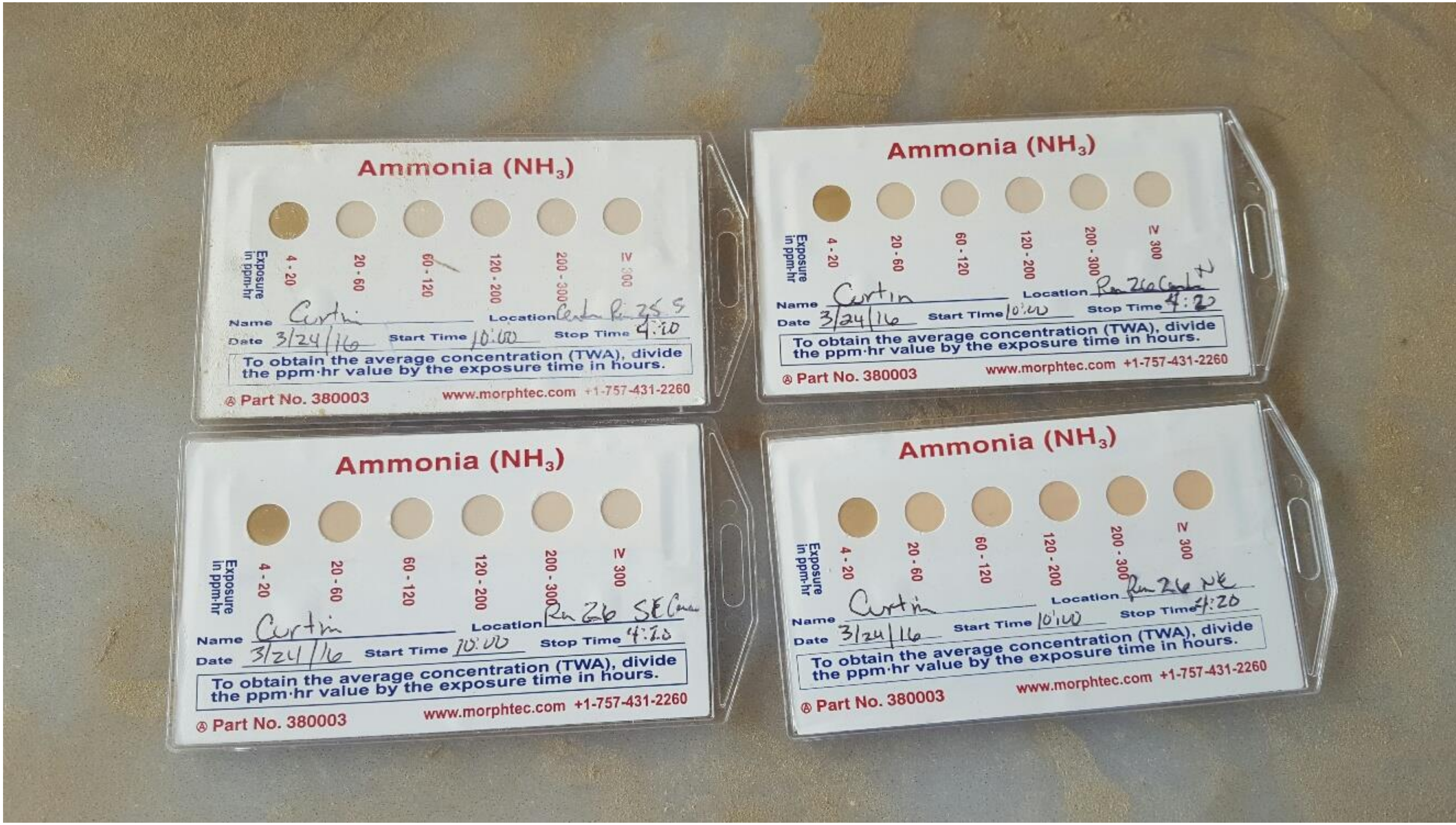
Pen space and capacity

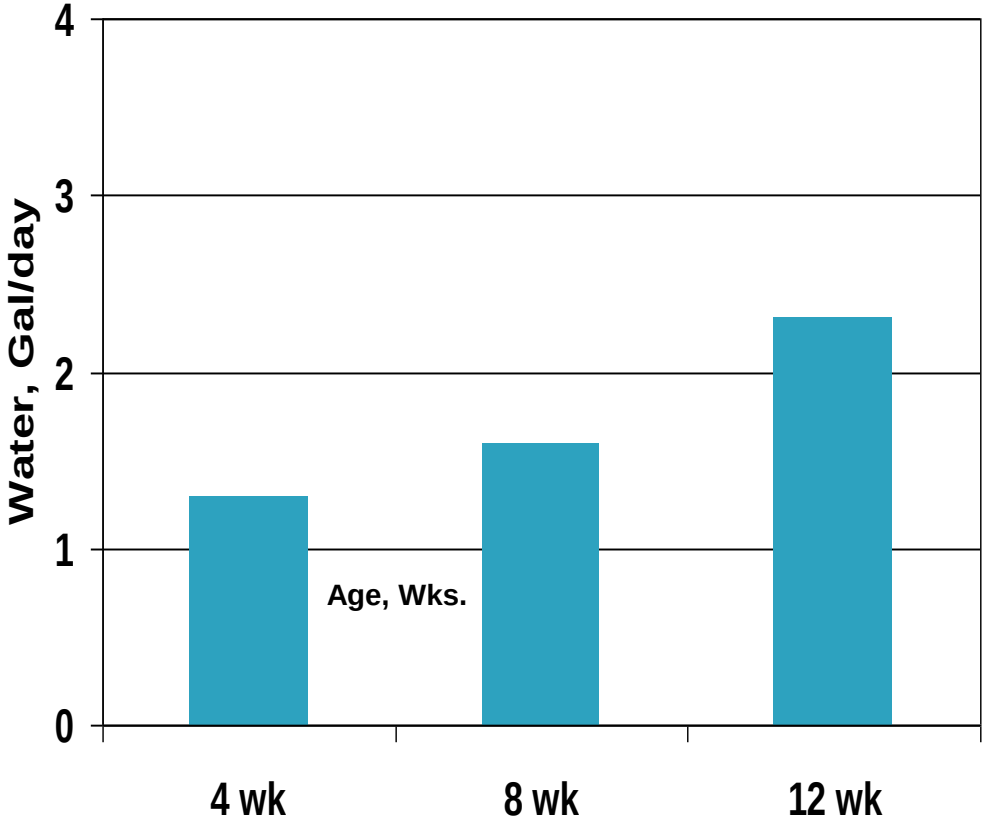
Pen Space

- Calf needs a minimum of 3.25- 4.255 sq. meters of bedding pack area
- Ideally less than 20 calves per pen. No more than 25.
- Fill in 7-10 days


Ammonia (NH_3)
Exposure in ppm·hr
4 - 20
20 - 60
60 - 120
120 - 200
200 - 300
≥ 300
Name Curtin
Date 3/24/16
Start Time 10:00
Stop Time 4:20
Location
To obtain the average concentration (TWA), divide the ppm·hr value by the exposure time in hours.
Part No. 380003
www.morphtec.com +1-757-431-2260

WHY WORRY ABOUT WATER?

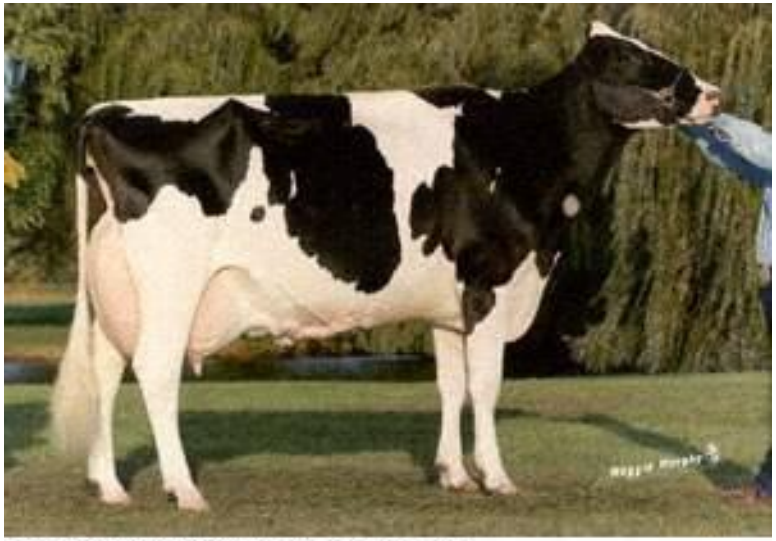
- Nutrient required in largest quantity
- Body is 56 to 81% water
- Poor water quality (high bacterial counts, TDS, iron, sulfur etc.) may limit growth and affect gut health and immunity
- Water tanks common source of respiratory bacteria
- Control *Mycoplasma bovis*



CLEANING AND SANITATION HOW TO DO IT RIGHT

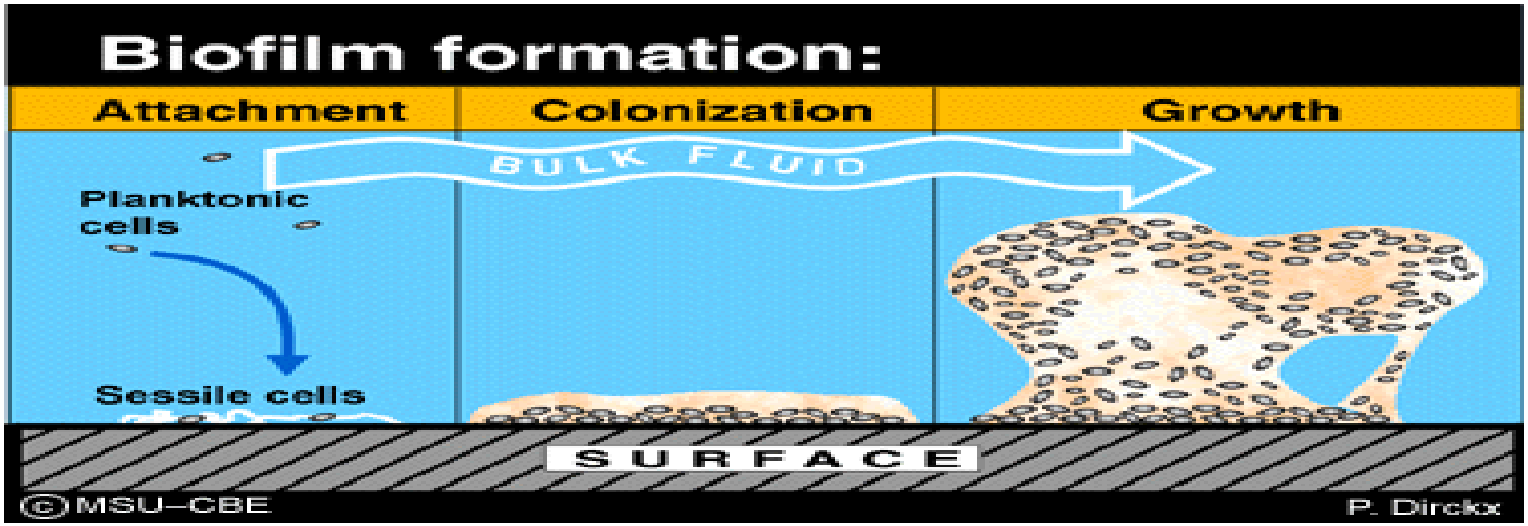
Donald C. Sockett DVM, MS, PhD

Diplomate ACVIM



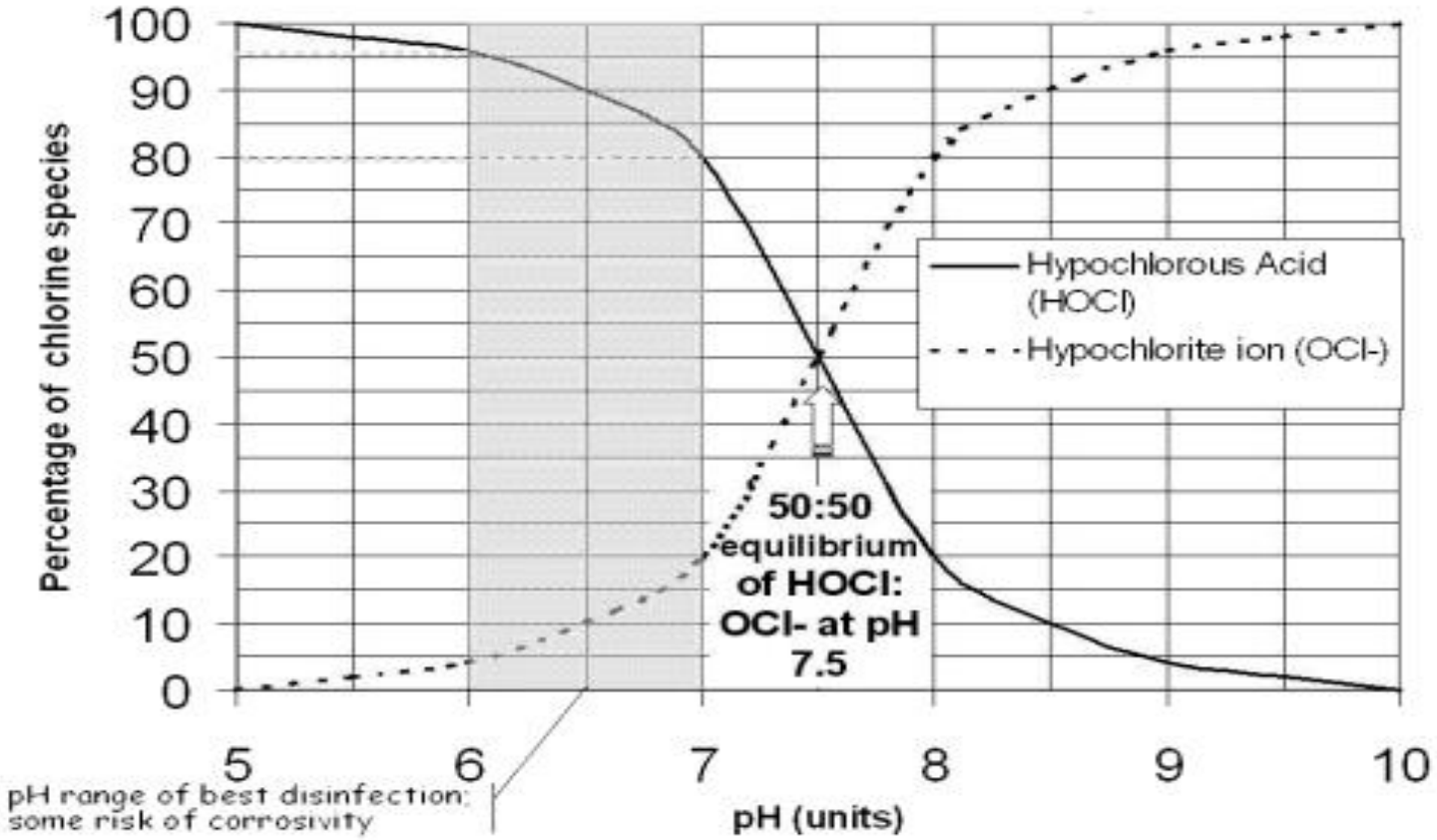
provided by Hoard's Dairyman

BIOFILM: Bacterial Habitat



- Planktonic – free floating/swimming bacteria in an aquatic environment – 10%
- Sessile – static organisms attached to surfaces, usually associated with a biofilm – 90-99%

Household Bleach: Effect of pH on Biocidal Activity



Bleach (sodium hypochlorite)

Bleach Dilution (City of Madison)	Water (pH)	Free Chlorine Concentration ppm	Percent Hypochlorous Acid	Percent Hypochlorite Ion
Tap Water	7.68	2.0	45	55
1:500	7.83	100	30	70
1:250	8.33	200	10	90
1:100	8.73	500	5	95
1:50	9.24	1000	3	97
1:25	9.57	2000	2	98
1:10	11.0	5000	.03	99.97

ATP Meter

Cleaning and Sanitation of Calf Feeding Equipment

- Clean (cannot disinfect filth!!)
- Rinse with luke (32-35 °C) warm water
- Manually wash with a brush for 2-3 minutes with hot water (≥ 60°C) that contains a chlorinated alkaline detergent (pH 11-12).
- Rinse with cold water and then rinse a second time with cold water that contains an acid (pH 2-3) and 50 ppm solution of chlorine dioxide
- Dry
- Sanitize with a 50 ppm solution of chlorine dioxide within 2 hours of use

Cleaning and Sanitation of Livestock Trailers and Calf Pens

- Remove all the bedding material
- Soak with water
- Alkaline foam cleaning (pH 11-13)
- Soak
- Rinse
- Acid Foam Cleaning (pH 3 - 4)
- Soak
- Rinse
- Dry
- Disinfect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Cryptosporidium parvum

Chemical	Concentration (ppm)	Contact time
Chlorine dioxide	100	1 minute
Hydrogen Peroxide (6%)	60,000	4 minutes
Peracetic acid	3,500	5 minutes
Ammonia (5%)	50,000	18 hours
Formalin (10%)	100,000	18 hours
Benzlkonium chloride (1%)	10,000	Not Effective
Chlorhexidine (2%)	20,000	Not Effective
Cresylic acid (5%)	50,000	Not Effective
Isopropanol (70%)	700,000	Not Effective
Sodium Hydroxide	200	Not Effective
Sodium Hypochlorite (6%)	60,000	Not Effective

OXIDIZER COMPARISION:

MATERIAL *** Activity Affected by pH	ORP (mVolts)	OXIDATION CAPACITY
Ozone (0^3)	2.07	2 Electrons
Peroxyacetic Acid (PAA)***	1.88	2 Electrons
Hydrogen Peroxide (H_2O_2)***	1.76	2 Electrons
Hypochlorous Acid (HOCl)***	1.49	2 Electrons
Chlorine (Cl_2)***	1.36	2 Electrons
Hypobromous Acid (HOBr)***	1.33	2 Electrons
Chlorine Dioxide (ClO_2) Lq.	0.95	5 Electrons


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The product in this container is mixed as directed on the "Technical Sheet For Use"
PREPARATION DATE
EXPIRATION DATE
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20
Record both preparation date and expiration date for each batch of 4-Liter Kit
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Chlorine Dioxide

LaMotte

Low Range
Chlorine Dioxide
ppm

0 0.25 0.5 1 3 5 10

Using a cup-size sample, immerse

• Keep wet

InstaTest® ANALYTIC

High Range

High Range Chlorine Dioxide

0 10 25 50 100 250 500

Using a cup-size sample, immerse strip for 2 seconds.

• Keep wet fingers out of the bottle.
• Cap bottle tightly

Livestock: Applications

Drinking Water:(Residual ClO_2 concentration 0.5-0.8 ppm)

- Remove: Biofilms, Bacteria, Viruses, Giardia, Cryptosporidia
- Remove: Iron, Manganese, Sulfites and Hydrogen Sulfide

Sanitize Calf Feeding Equipment (50 ppm ClO_2)

- 1-2 minutes contact time
- Bottles/Nipples, Buckets, Pasteurizers, Mixing Equipment, Etc.

Misting Livestock Present (100 ppm ClO_2)

- ≥ 30 seconds contact time
- Locations: Maternity Pens, Calf Pens, Bedding Packs, Calf's Feet, Legs, Brisket and Belly

Environmental Disinfecting (250 ppm ClO_2)

- 5-10 minutes contact time
- Locations: Maternity Pens, Calf Pens, Calf Barns, Calf Transporters, Automated Calf Feeders, Livestock Trailers

- Environmental Fogging (500 ppm ClO_2)
  - ≥ 30 minutes contact time
  - Locations: Calf Barns, Livestock Trailers

Case Study

Dairy (500 milking cows) losing 25% of heifer and bull calves with bacterial septicemia at 3-5 days of age

Calves removed from calving pen within 30 minutes of birth

FPT less than 2%

Excellent colostrum quality (bacterial counts less than 10,000 cfu/mL)

Fed minimum of 2.0 lbs. of dry matter/hd/day

Case Study

Bull calves no changes in animal husbandry (control)

Heifer calves (treatment) incorporated University of Wisconsin's cleaning and sanitation protocols

No difference in FPT between bull and heifer calves

No difference in dry matter intake between heifer and bull calves

Same calf feeders for both groups of calves

Results

Death loss remained at 25% for the bull calves.

Cause of death bacterial septicemia

Death loss declined to less than 2% for the heifer calves. No death loss for 6 months.

n = 111 heifers, 105 bulls

$p < 0.001$


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Bootie Culture Results

- Livestock Trailer: Culture positive for *Salmonella* Montevideo
- Hutch Alleyways: Culture positive for *Salmonella* Montevideo
- Calving Pen Straw: Culture positive for *Salmonella* Montevideo
- Milk Preparation Room Floor: Culture positive for *Salmonella* Montevideo

Recommendation(s)

Bootie Culture Results
Endemic: *Salmonella* Dublin problem

- Maternity Pen(s): Culture Negative for Salmonella
- Calf Milk House Floor: Culture Negative for *Salmonella*
- Cleaned and Disinfected Calf Hutches: Culture Negative for *Salmonella*
- Calf Barn Alleyways: Culture Negative for *Salmonella*
- Transition Barn Waterers: Culture Negative for Salmonella
- Recommendation(s):