Velkommen til Kursusrækken i kalvesundhed

1. samling 21-22/9-2016 på Rold Storkro

Henrik Læssøe Martin

Den Europæiske Landbrugsfond for Udvikling af Landdistrikterne:
Danmark og Europa investerer i landdistrikterne

Miljø- og Fødevareministeriet
NaturErhvervstyrelsen

Den Europæiske Landbrugsfond
for udvikling af Landdistrikterne

LDP 2020

[redacted]

Hvorfor lave kursus i kalvesundhed?

Malkekvægracer										
Dødelighed ved fødsel og af levendefødte kalve	Antal	Tyr			Kvie			Alle		
	Fødsler	Fødsel	30 dage	180 dage	Fødsel	30 dage	180 dage	Fødsel	[illegible]	[illegible]
Fødselsår		%	%	%	%	%	%	[illegible]	[illegible]	%
1999	691029	7,1	5,6	10,2	4,5	4,5	[illegible]	[illegible]	[illegible]	9,0
2000	683994	7,6	5,7	10,5	4,9	[illegible]	[illegible]	[illegible]	5,1	9,0
2001	658508	7,5	5,8	11,2	[illegible]	[illegible]	[illegible]	7,0	5,4	9,7
2002	635470	7,6	5,6	[illegible]	[illegible]	[illegible]	8,2	7,1	5,1	9,7
2003	629511	7,6	[illegible]	[illegible]	[illegible]	4,5	7,7	7,0	5,0	9,3
2004	612356	7,9	[illegible]	[illegible]	[illegible]	4,1	7,0	7,3	4,5	8,5
2005	587281	[illegible]	[illegible]	[illegible]	5,2	4,1	7,0	7,3	4,5	8,2
2006	[illegible]	[illegible]	[illegible]	9,9	5,3	4,5	7,3	7,4	4,9	8,6
2007	[illegible]	[illegible]	5,0	9,5	5,1	4,4	7,0	7,3	4,7	8,2
[illegible]	[illegible]	7,8	4,7	8,9	4,9	4,2	6,7	7,0	4,5	7,8
[illegible]	[illegible]	7,7	4,8	9,0	4,9	4,2	6,7	6,9	4,5	7,8
[illegible]	607256	7,6	5,3	10,4	5,0	4,7	7,3	6,8	5,0	8,7
2011	617778	6,9	4,5	9,6	4,8	4,1	6,7	6,4	4,3	8,0
2012	624002	6,7	4,5	9,4	4,5	4,0	6,5	6,1	4,2	7,8
2013	619268	6,4	5,0	9,7	4,3	4,6	7,2	5,8	4,8	8,3
2014	620769	6,7	4,5	9,3	4,0	4,1	6,6	5,8	4,3	7,7
2015	614554	6,6	4,3	9,2	4,0	3,7	6,1	5,7	4,0	7,4
2016	424403	6,0	4,2	8,2	4,2	3,6	6,0	5,5	3,9	6,9

Kvægbrugets eget mål: Dødelighed 1-180 dg maks. 5,5 % i 2018

Kursusrække i kalvesundhed

- Der er brug for fokus på godt opdræt
    - Godt opdræt giver holdbare køer
- Det bliver en god blanding af teori og praksis-med besætningsbesøg
- Hjemmeopgaver mellem samlingerne
- Samarbejde mellem SEGES og DDD

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LDP 2020

[redacted]

Oversigt

- Samling 1. 21-22/9 Rold Storkro
  - Den nyfødte kalv
  - Råmælk
- Samling 2. 16-17/11-2016
  - Scanning af lunger
  - Kælvning – Management

Dagens program

Wednesday September 21th

	Topic	**Lecturer**
8.30-9.00	Arrival / breakfast	
9.00	Welcome / introduction	Henrik Læssøe Mar-tin & Henrik Schmidt (H&H)
9.15	Goals for the young stock program	Sandra Godden (SG)
	Newborn calf care	SG
	Colostrum management	SG
12.00-13.00	Lunch	
13.00	Quality control of colostrum etc.	Christine Maria Røntved (CMR)
13.50	Nutrition of the preweaned calf	SG
14.45	Management of pasteurized milk systems	SG
15.45	Coffee	
16.10	Quality control of milk and milkreplacers	CMR
17.00	Evaluation and plans for future meetings	H&H
18.00	Dinner	
19.30-20.30	Housing and management – Pros & cons.	SG

Torsdag

	Topic	Lecturer
8.00-9.00	Disease detection, diagnosis and treatment	SG
9.00	Introduction to farm visit	
9.30	Departure to farm	
10.00-12.00	Farm visit	
12.30	Lunch	
13.15	Catching up on farm visit	SG
14.00 – 14.40	Assessment of data related to production / Relevant lab tests	CMR
14.40	Introduction to homework	CMR
	Coffee	
15.00	Evaluation and summary	H&H
15.30	End of course	

Evaluering

- Hvad synes i om dagen i dag?
- Hvad synes i om 2 dages kursus?

Samling 2 - 16-17/11-2016

- Scanning af lunger + Trouble shooting on the farm v. Ramon Armengol
  - Hvor mange kan tage scanner med + sprit?
- Kælvning – Management v. Gustavo Schuenemann
- Opsætning af handlingsplaner/protokoller v. Vibeke Fladkær Nielsen

Quality control of colostrum & CCP

Calf seminar, September 21-22, 2016

By DVM, PhD Christine Maria Røntved

Ed1. 19.09.2016

What is my talk about?

- Colostrum composition
- The 4 most important parameters of colostrum management and why
- How do we define colostrum quality
- Critical control points (CCP) in colostrum management

What do I hope you learn?

- Get more insight and background
- Learn to ask new questions
- New inspiration to work together with the farmers

The compostion of colostrum

Immune package

Nutrient, vitamin & mineral Package

Gut growth Package

Enzyme Package

Antiinflammatory package

The 4 major factors of importance to colostrum feeding

TIME, QUALITY, VOLUMEN & TEMPERATURE

The coloquick movie by Calvex (English):
https://youtu.be/mliZuPI6HhI

Coloquick anvendelse (Danish)
https://youtu.be/Bvl-HPnMbg4

Colostrum management
Critical control points (CCP)

Raw colostrum directly suckled by the calf from the cow

Calving → Colostrum time of feeding
actual intake (volume)
No sorting of quality or pathogen status
?

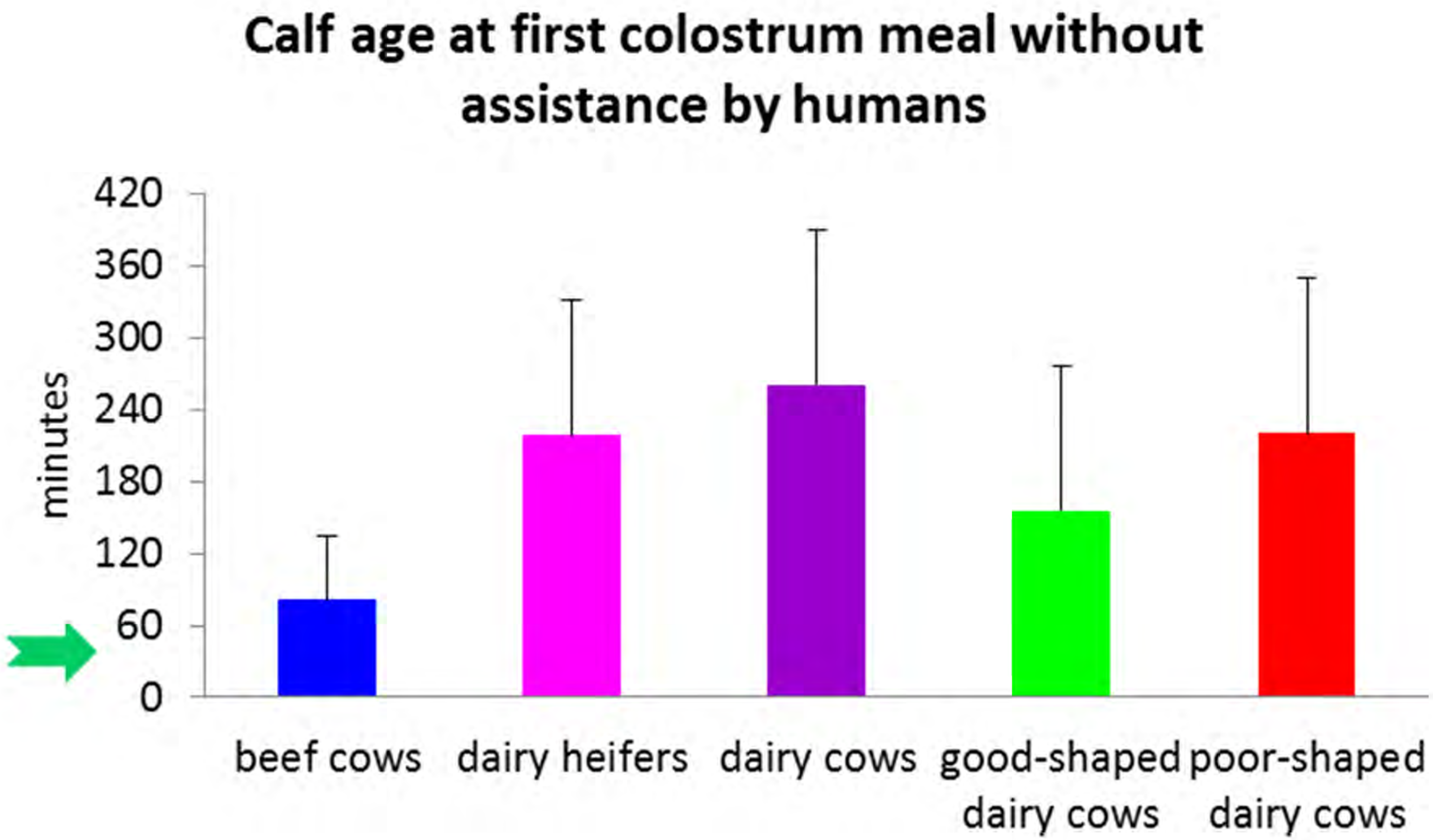
Milked raw colostrum fed directly to the calf

Addition over environmental bacteria
Carry over effect between cows

CCP1 Calving | CCP2 Milking → CCP3 Simpel-Quality test ? → CCP(4)10 Colostrum time feeding & intake (volume)

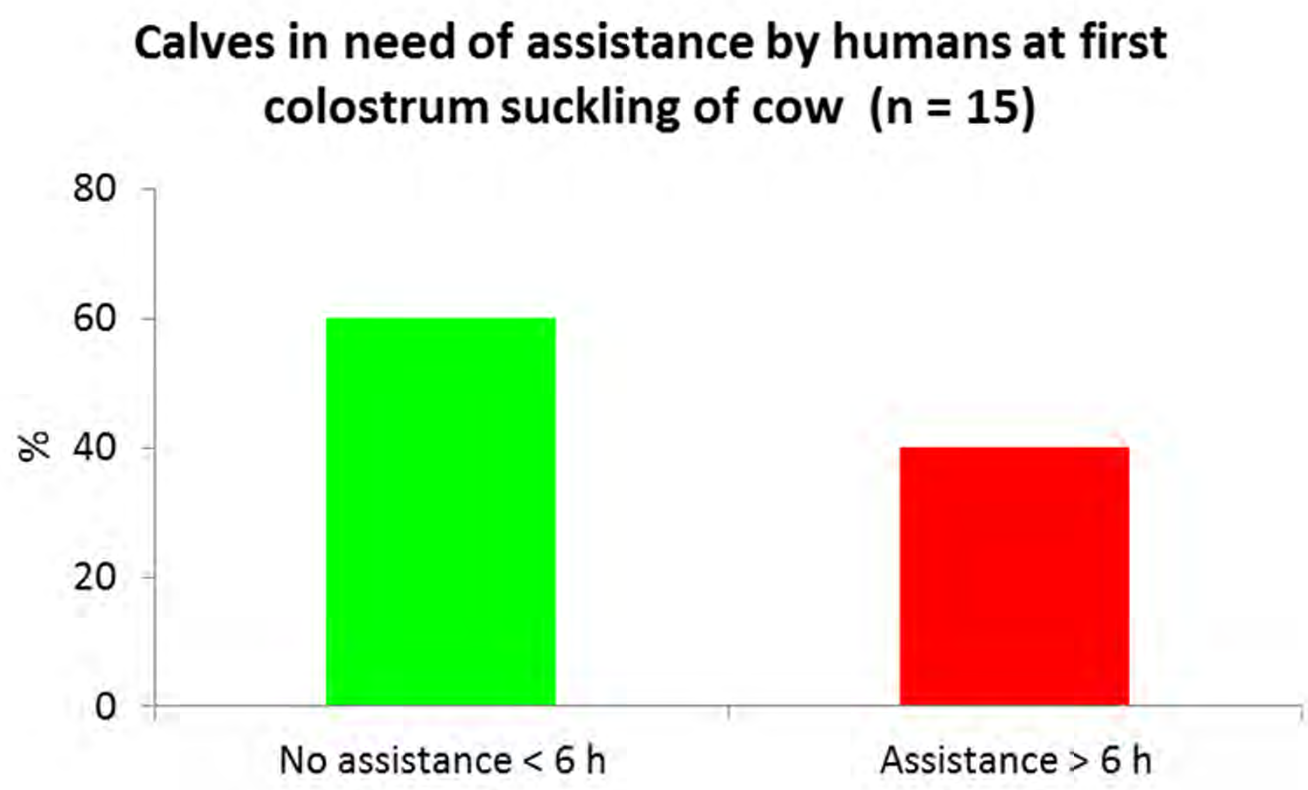
CCP1 Calving | CCP2 Milking → CCP(4)10 Colostrum time feeding & intake (volume)

TIME: When will a calf start to suckle colostrum?



Selman et al., 1970

Calves in need of calving assistance - how many?

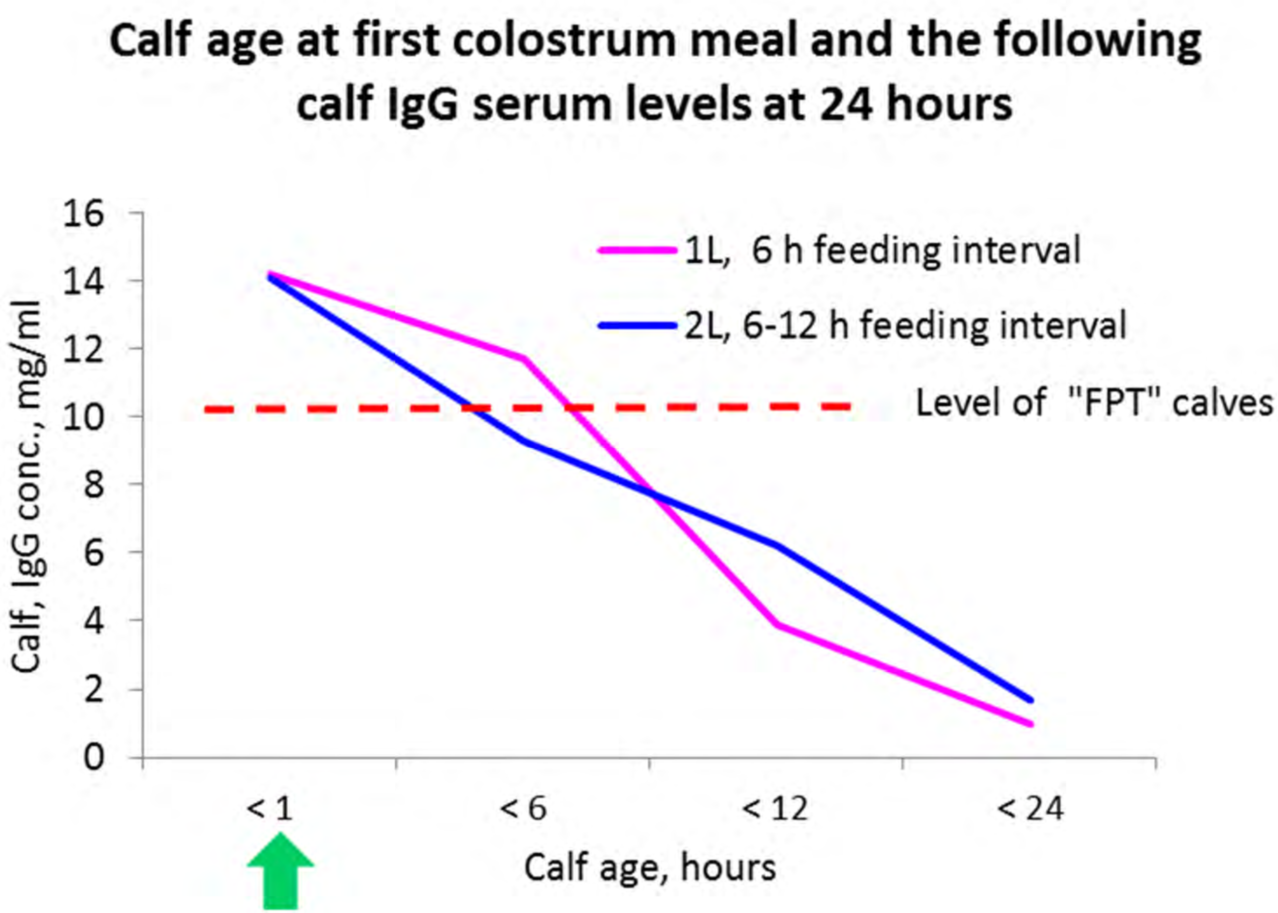


Rajala and Castrén, 1995

Time: calving vs time of feeding?

Calving alarms on the market

The effect of time & volume



White, 1993
Matte et al., 1982

CCP 2 or 10 – time of feeding?

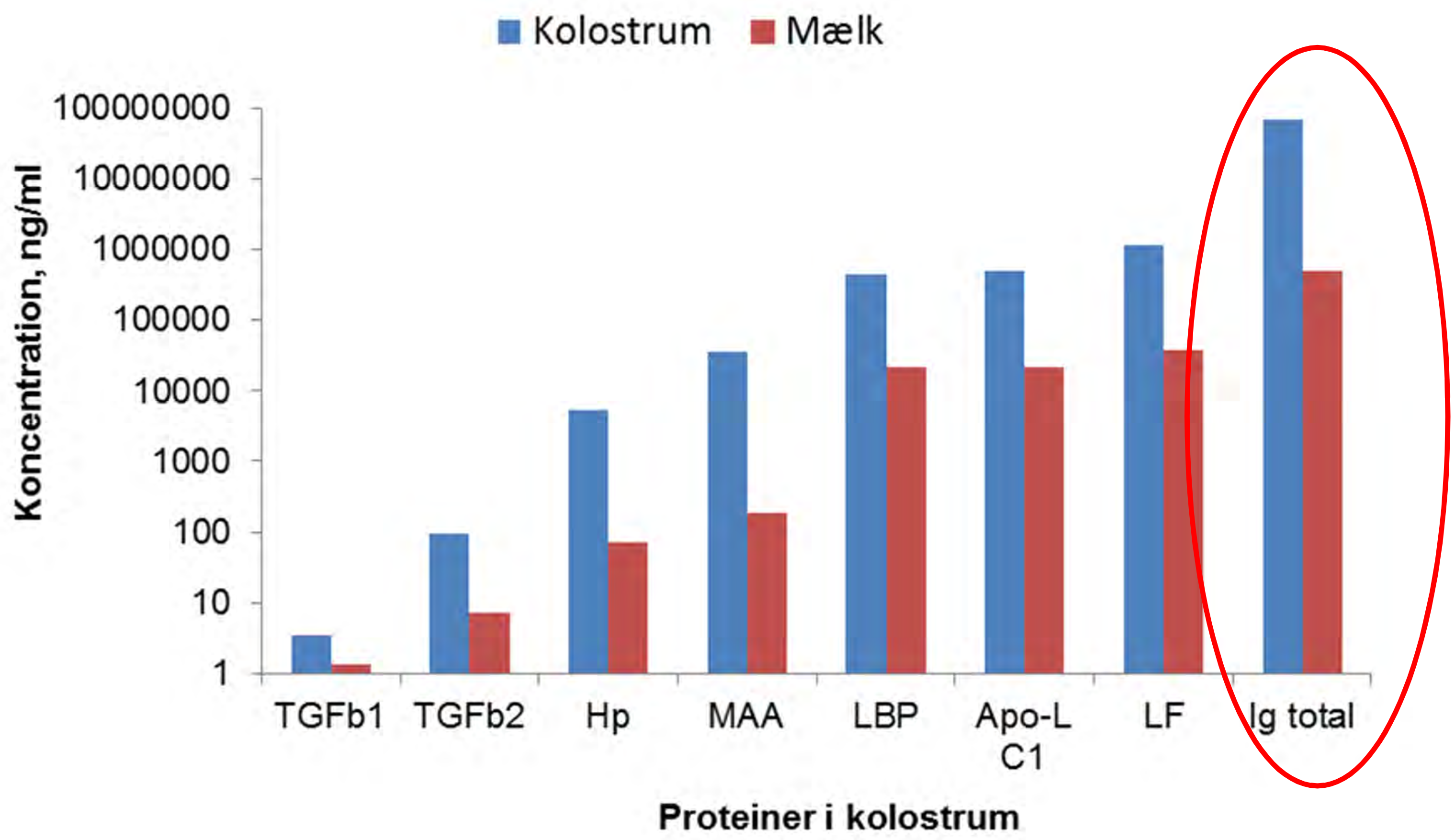
- Do you know and record the actual calving time?
- Use of any calving alarm?
- Do you feed raw or stored colostrum?
- Who is responsible for milking th cow and feeding the calf? The same or two different persons?
- How do you thaw heat colostrum?
- Colostrum feeding – **as fast as posssible** – **optimal colostrum < 2h.**

How do we define colostrum quality?

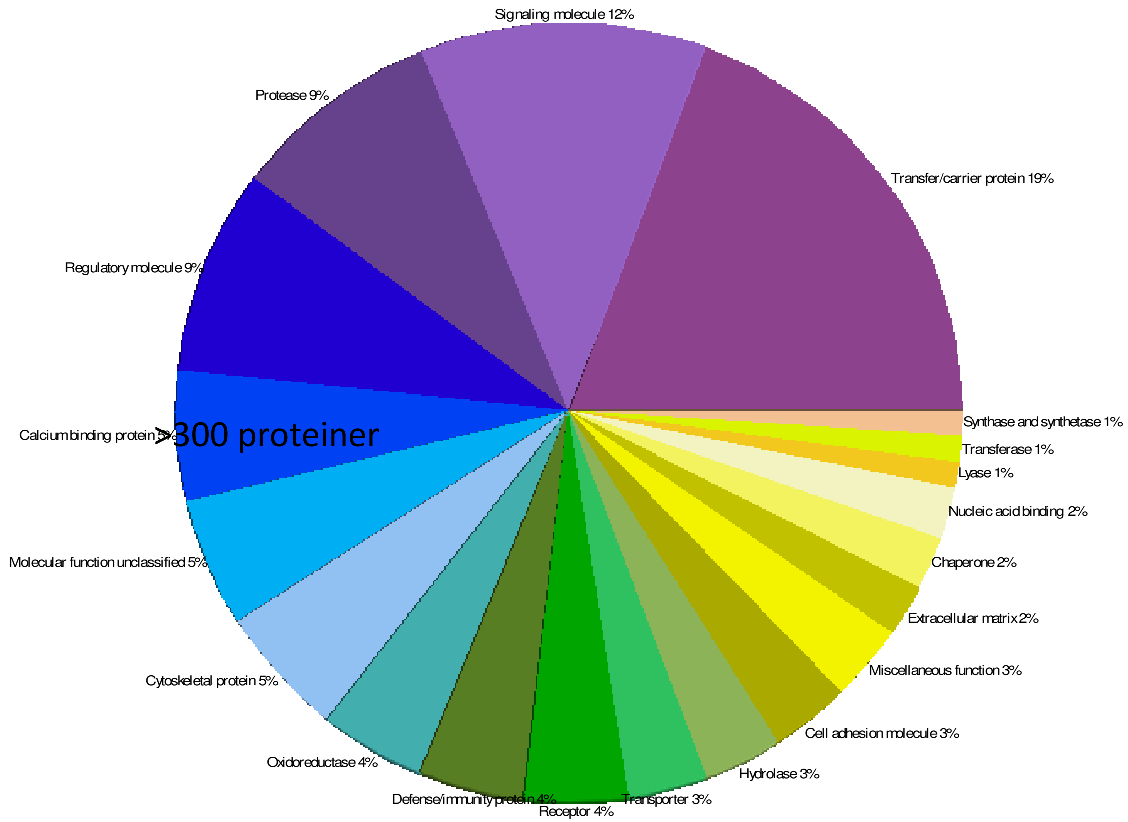
- Content of immunoglobulins (and many other immune proteins…..)?
- Content and distribution of immune cells?
- Content of pathogens?
- Content of feed damaging bacteria?
- Content of nutrients?
- pH?

What are the acceptabel levels?

Concentrations of immune proteins in colostrum vs milk (early lactation)



Distribution of proteins in terms of biological function

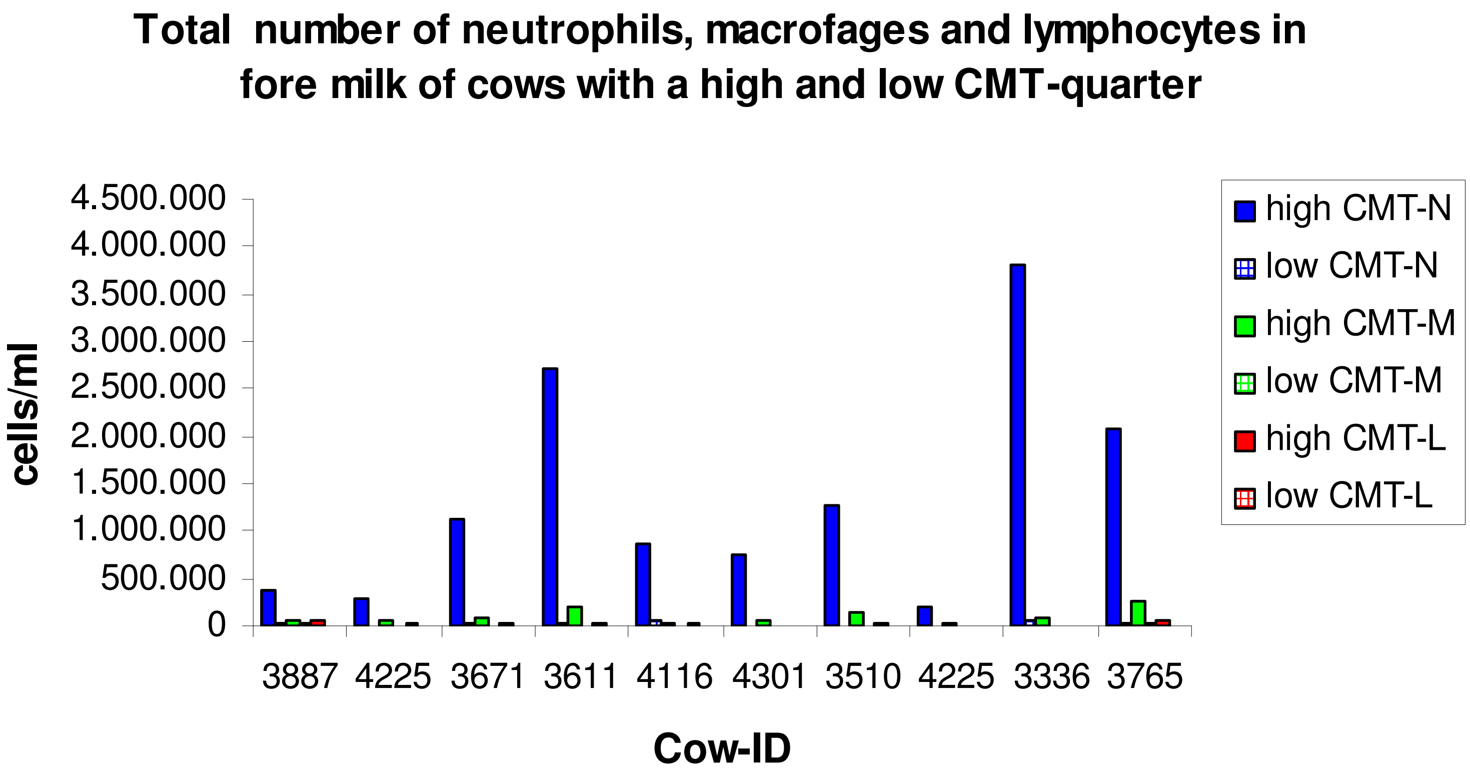


Differential cell count in bovine milk

%	Normal milk	Dry secretion	Colo-strum	Subclinical mastitis	Clinical mastitis
Epithelial cells	2-15/56?	?	?	7-21	2-21
Granulo-cytes	5-25	5-15	25-40	>20	>60
Mono/macro-phages	35-85	49-90	35-50	<70	<40
Lymphocytes	15-30	5-40	20-30	10	5
SCC/ml	$<1\text{-}2 \times 10^5$	10^6	10^6	$10^5\text{-}10^6$	$10^6\text{-}10^8$

Modified from Persson waller slide

Differential cell count by microscopy



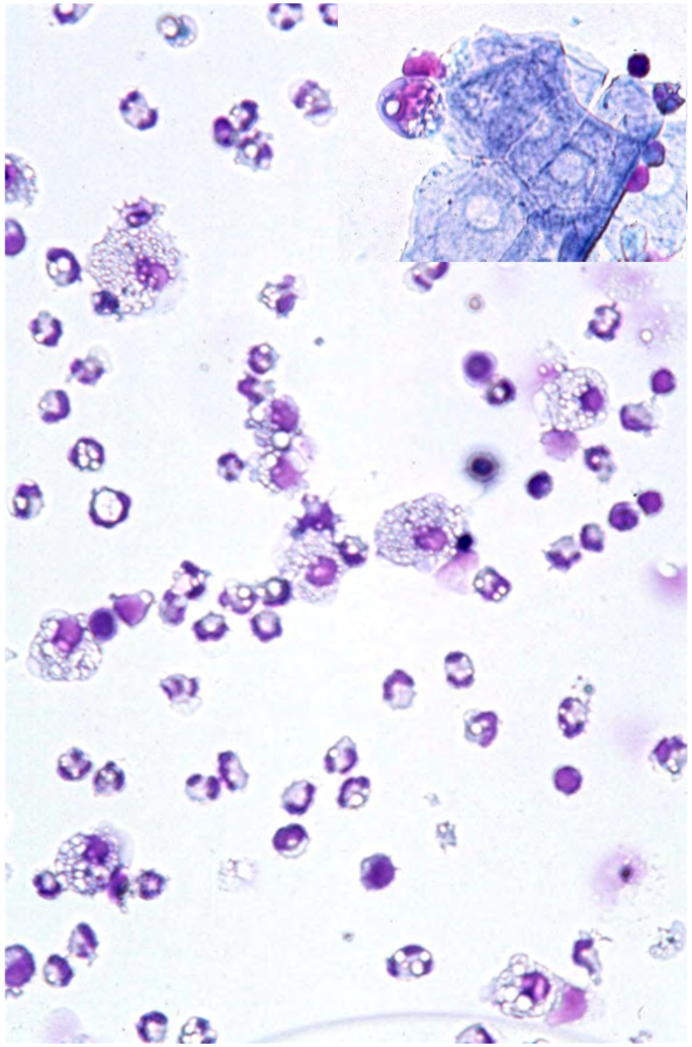
Samples from dairy cows with unaltered milk appearence that contributed to bulk milk

~30% of the cows have subclincal or clincal mastitis at calving

The importance of immune cells?

Facts:

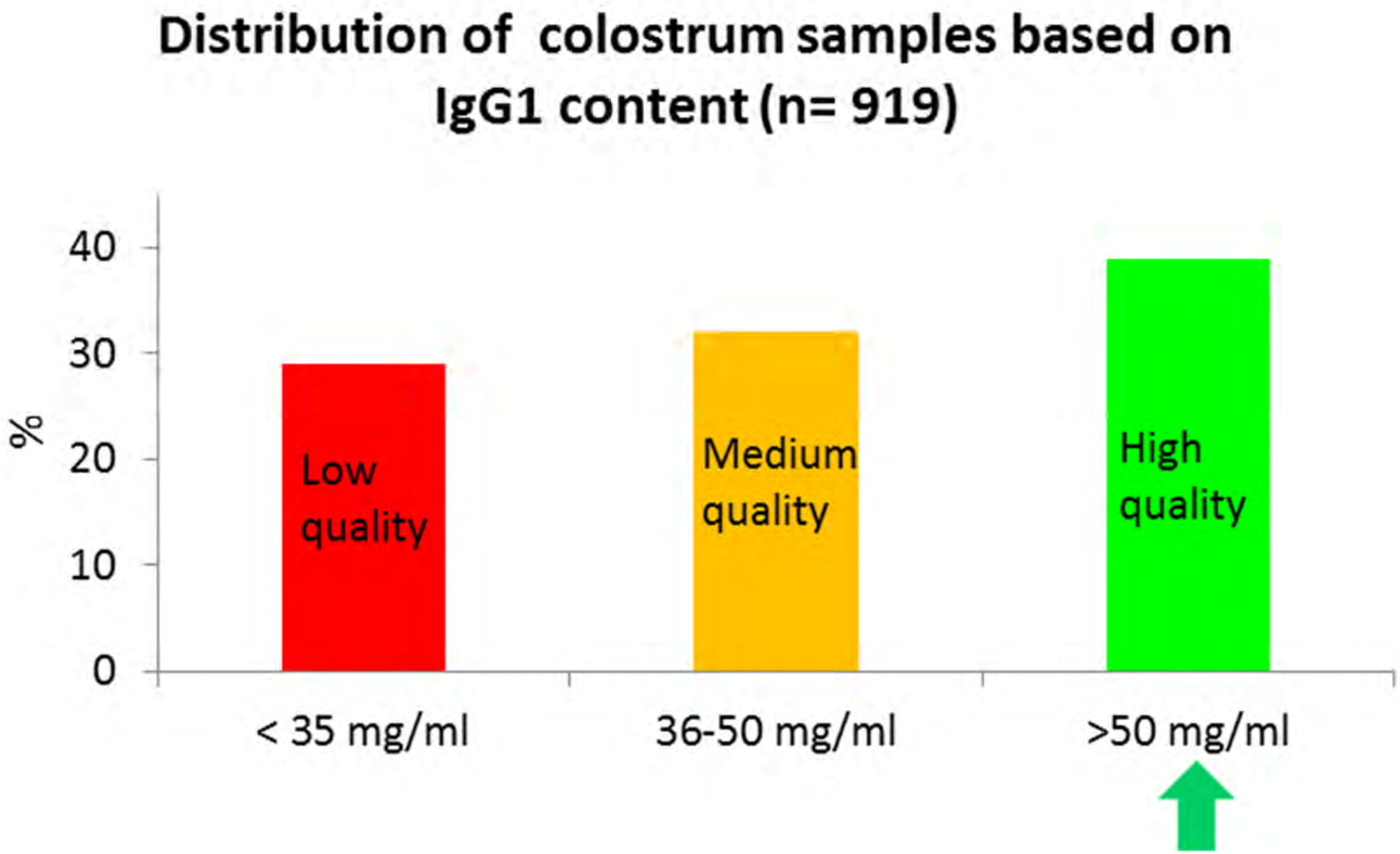
- SCC increased at calving, but vary variable between cows.
- Increased mononuclear counts
- Many dead cells
- Will enter to calf gut epithelium (self vs non-self)
- Can not crosstalk with the calfs immune system
- Can harbour pathogens
- SCC are killed by freezing
- SCC are killed by 60ºC heat treatment



How do we measure IgG quality on farm?

Brix%: R=0.71 correlation to IgG measure by RID

Distribution of colostrum quality when determined by IgG?



Pritchett et al., 1991

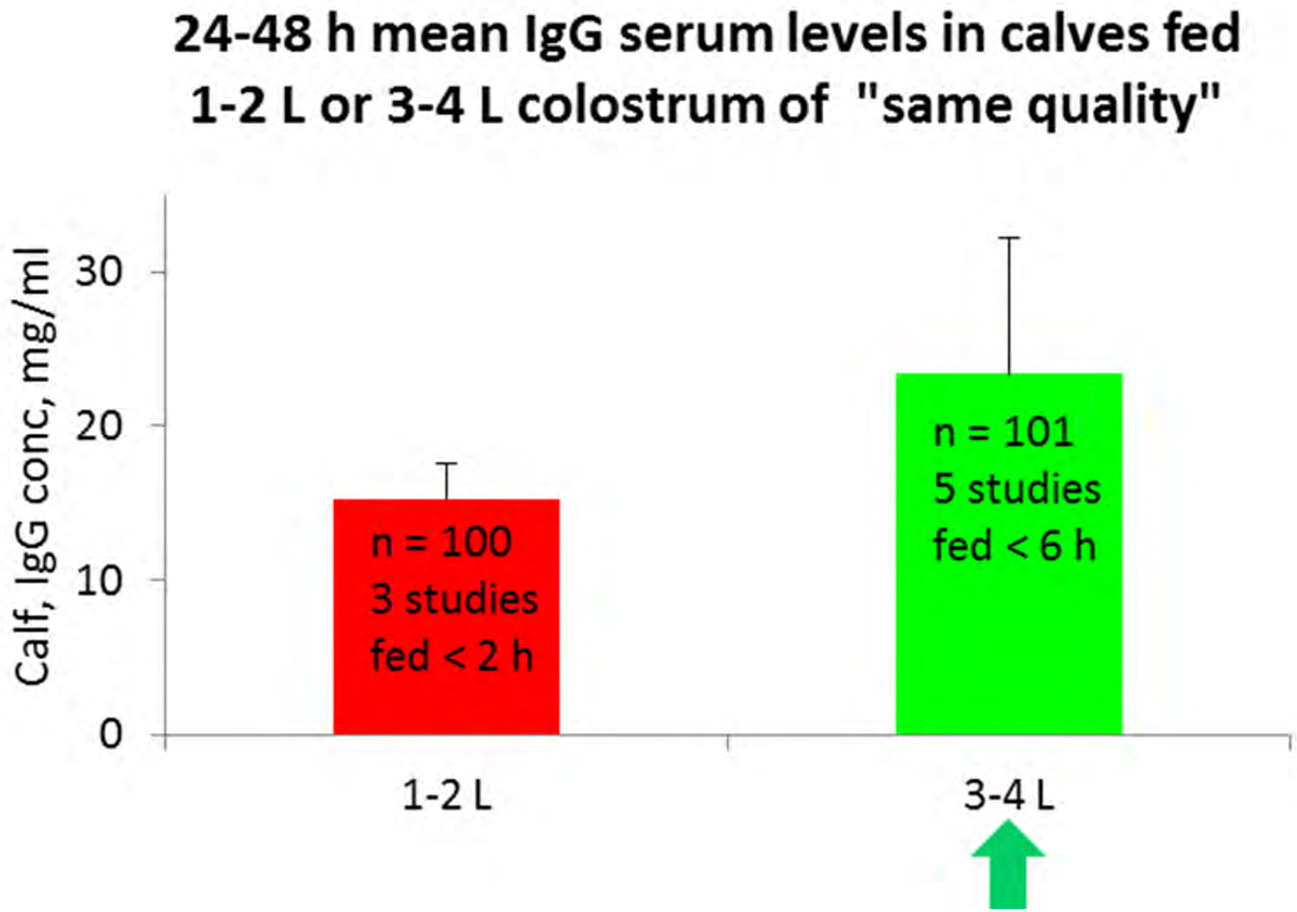
Distribution of colostrum quality when determined by Brix% and IgG

Recalculation of Brix% to Ig concentraation:Ig (g/L) = (Brix%-17,546)/0.0932

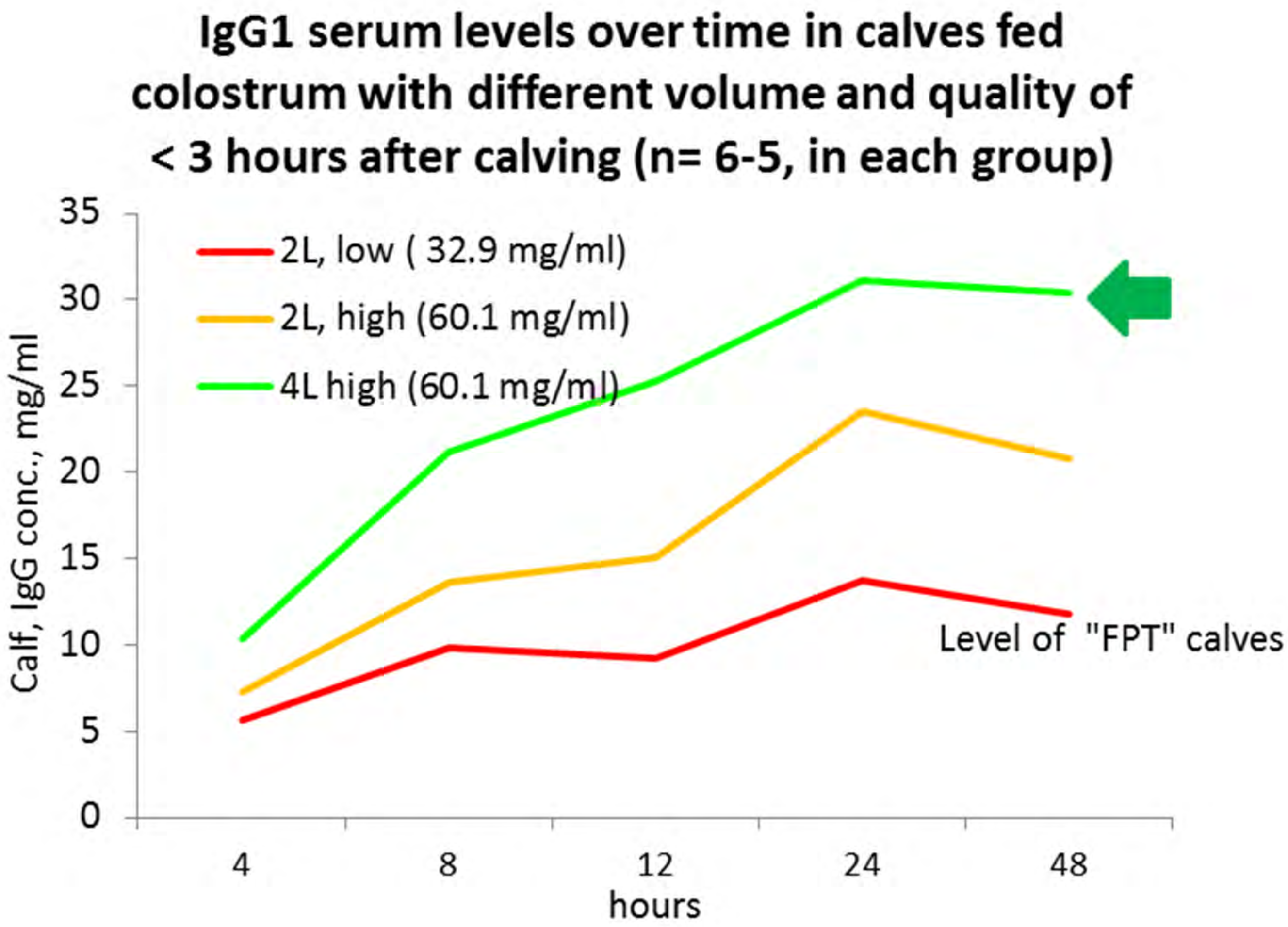
R = 0.71 (Bielmann et al. 2010)

Antal prøver	Race	Besætninger	IgG niveau g/l	Gennemsnit g/l	Prøver med < 50 g IgG/l	Kilde
1250	NRF	119	4-235	45	58%	Gulliksen et al., 2008 http://www.coloquick.dk/media/2010/2-%20norwegian.pdf
919	HOL	1	<20-110+	48		Pritchett et al., 1991 http://www.journalofdairyscience.org/article/S0022-0302(91)78406-3/pdf
88	JER	1	30-121	70		Quickly et. al, 1994 http://www.calfnotes.com/pdffiles/CNman19.pdf
55	HOL	55	11-70	35		Kehoe et al., 2007 http://www.journalofdairyscience.org/article/S0022-0302(07)71869-6/abstract
457	HOL	12	9-186	76		Swan et al., 2007 http://www.journalofdairyscience.org/article/S0022-0302(07)71841-6/fulltext
214	HOL	11	9-166	38		Baumrucker et al., 2010 http://www.journalofdairyscience.org/article/S0022-0302(10)00312-7/fulltext
68	BS	1	<20-140		<20 = 15 %	Faber et. al, 2005 http://pas.fass.org/content/21/5/420.full.pdf+html
282	HOL	1	<10-166 (10-33 brix)	48 (22 brix)	44%	Preben Laursen. 27/3 2015- 31/12 2015*
808	HOL	1	<10-144 (15-31 brix)	40 (21,3 brix)	62%	Nørgaard Agro. 4/11 2014 -14/1 2015**
140	HOL øko	1	<10-118 (15-28,5 brix)	59 (23,2 brix)	15%	Torben Brødbæk 1/5 - 27/8 2015***

The effect of volume



The effect og volume & IgG quality



Morin et al., 1997

The volume test

- Colostrum volume: 10 % of bodyweight
- Fixed vs. flexible volume feeding?
- How accurate do farmers actually measure the volume?
- How accurate does he think he measure the volume?
- How accurate is it in a fixed commercial system?

- https://www.youtube.com/watch?v=drw4Pn4rIm0

CCP colostrum amount & intake

- What volume do you use?
- How do the farmer measure the volume – and how accurate is it?
- What volume do the farmers feed or think that they feed feed?
- What is the actual intake of the calf?
- How much does this volume variation influence the calculated intake of IgG?

Colostrum management
Critical control points (CCP)

Stored cooled or frozen colostrum fed to the calf

CCP1
Calving

CCP2
Milking

CCP3
Quality testing & sorting (pathogen)

CCP4
Storage container & volume

CCP5
Heat-disinfection treatments in container

CCP6
Short-term storage & cooling temperature

CCP7:Thawing time & temperature

CCP8: Heating to 42 ºC feeding temperature

CCP9: Feeding equipment

CALF CCP10: time & intake of quality- classified colostrum of known volume

CCP3 quality testing & sorting

- Do your sort and label your colostrum according to cow pathogen status?
- Do you produce enough colostrum, so that you can discard colostrum from ParaTB, S. dublin, Strep. agalectiae, Mycoplasma bovis & Staph-aures cows?
- Do you desinfect your colostrum by heat treatment according to cow pathogen status?
- Do you distinguish between heifers and bulls when using heat treated colostrum from infected cows?

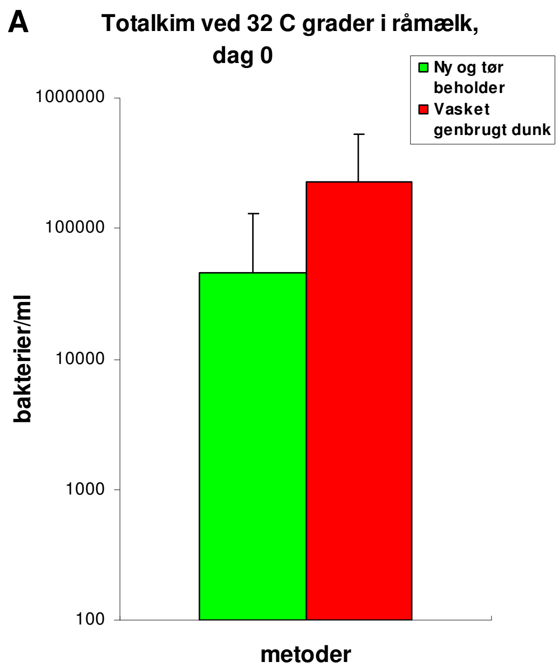
CCP4 – storage container material and cleaning possibilities

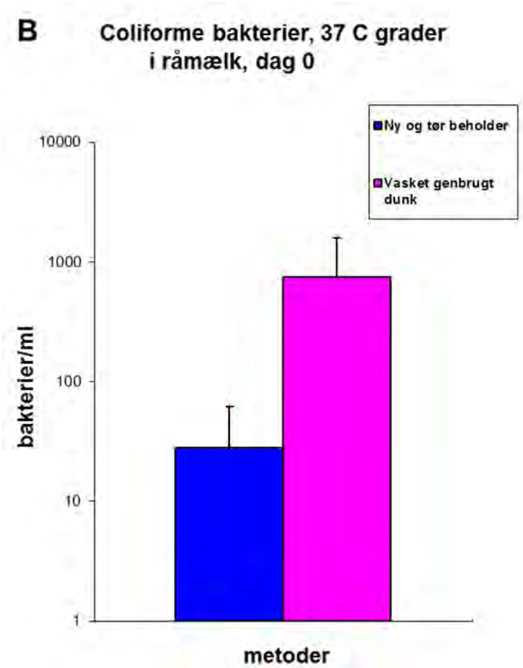
CCP4 – storage: material & cleaning

- What setup and material do you use for storage?
- Bag vs. container vs. bucket
- Single use vs multiple use?
- Multiple use: How do you clean your system?

- ~~Bag vs. container~~ vs. bucket with a lid

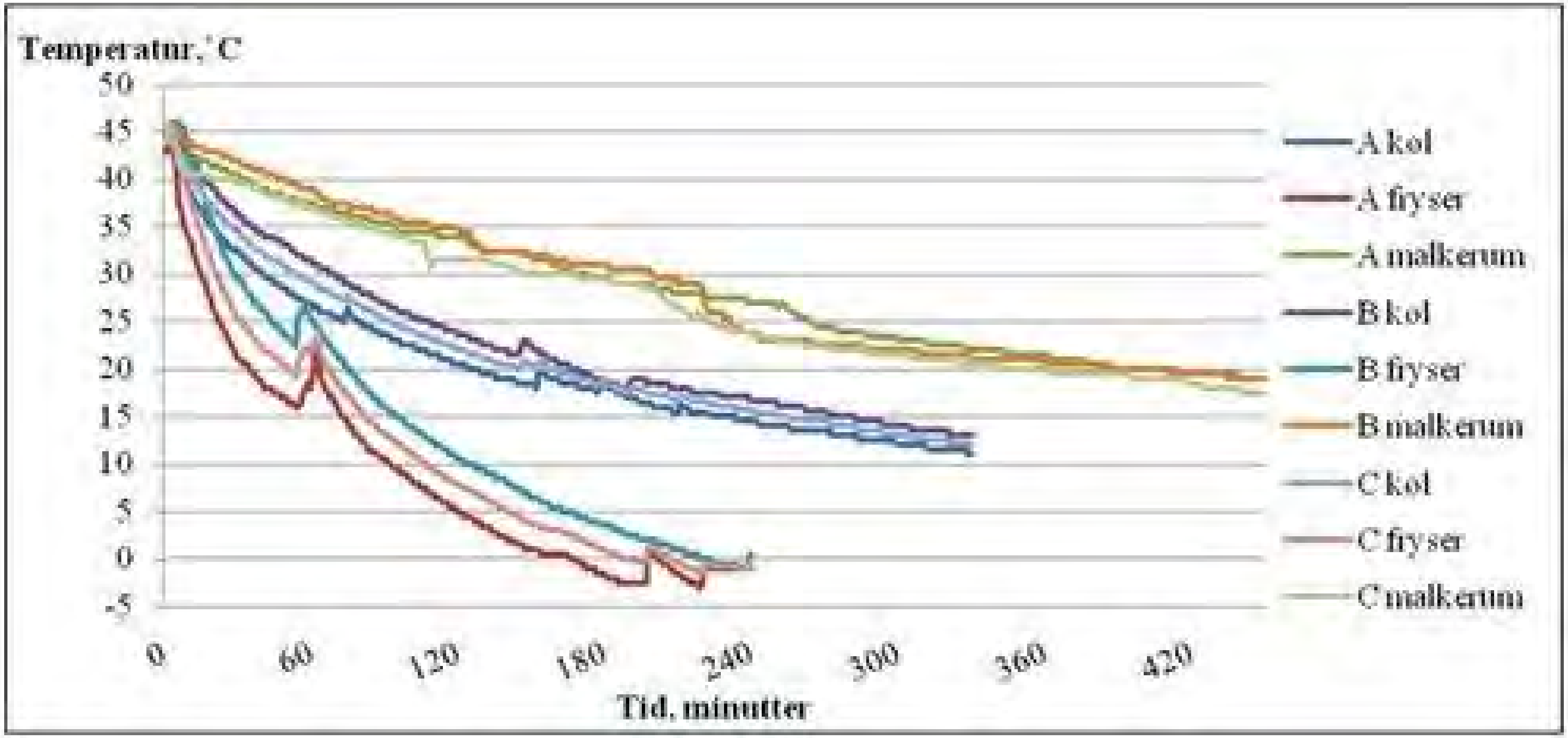
CCP4: Clean single-use vs re-used washed container – TPC & coliform counts





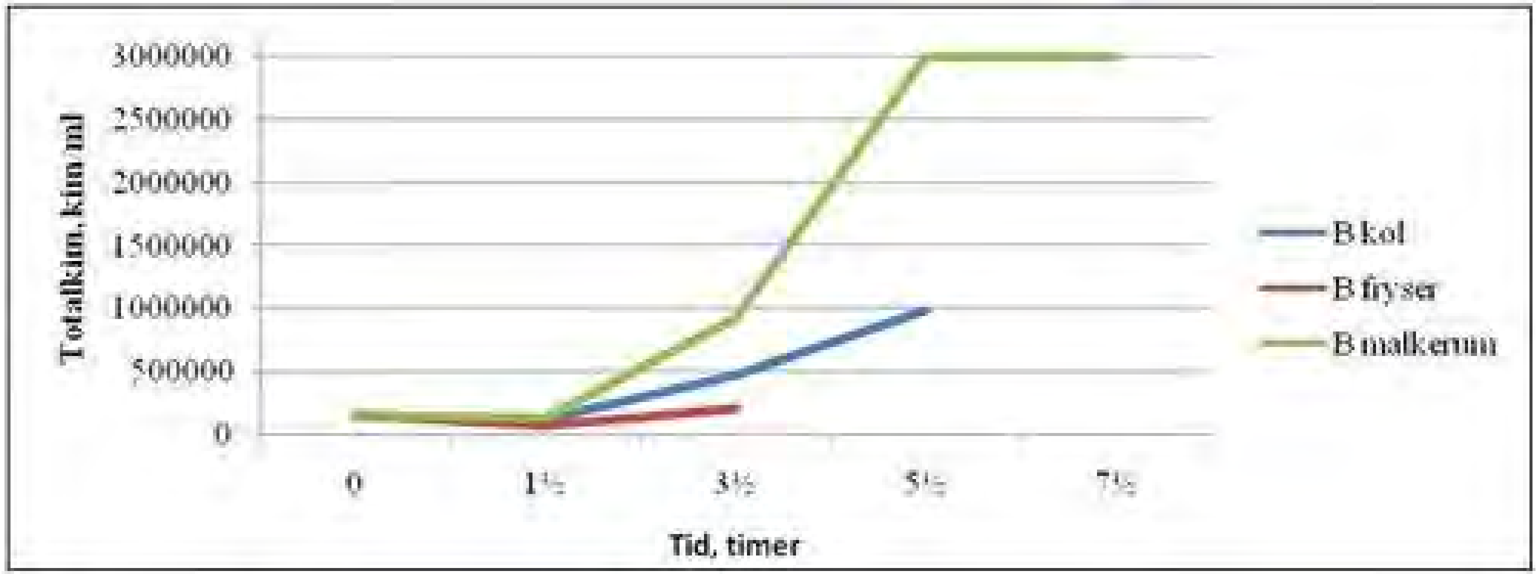
CCP6: Time of cooling, freezing & RT in colostrum

Barret: http://www.landbrugsinfo.dk/Kvaeg/Malkekoeer-og-opdraet/Smaakalve/Sider/Nedkoel_raamaelken_umiddelbart_efter_udm.aspx



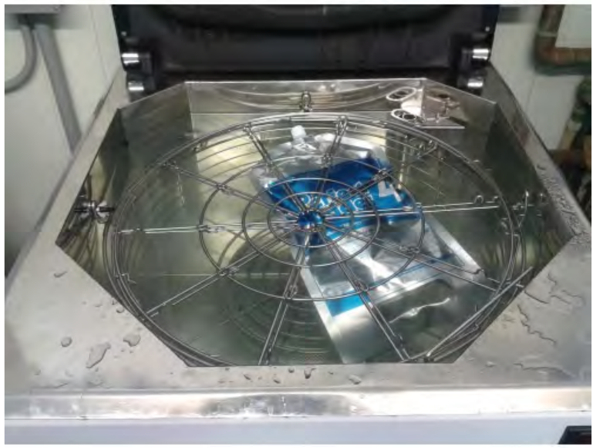
CCP6: Time of cooling & freezing & RT
Total count of bacteria in colostrum

Barret: http://www.landbrugsinfo.dk/Kvaeg/Malkekoeer-ogopdraet/Smaakalve/Sider/Nedkoel_raamaelken_umiddelbart_efter_udm.aspx

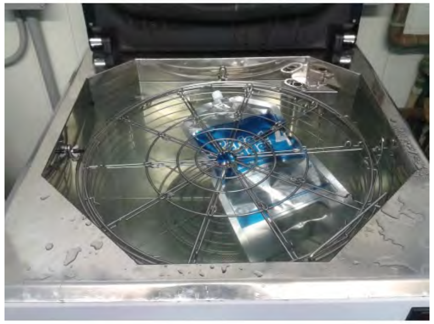


Freezing best microbiological solution.
Short-term frozen colostrum results in similar levels of IgG in calf blood as fresh fed colostrum (Holloway et al., 2001).

CCP7/8: Time of thawing?
How long in different system?

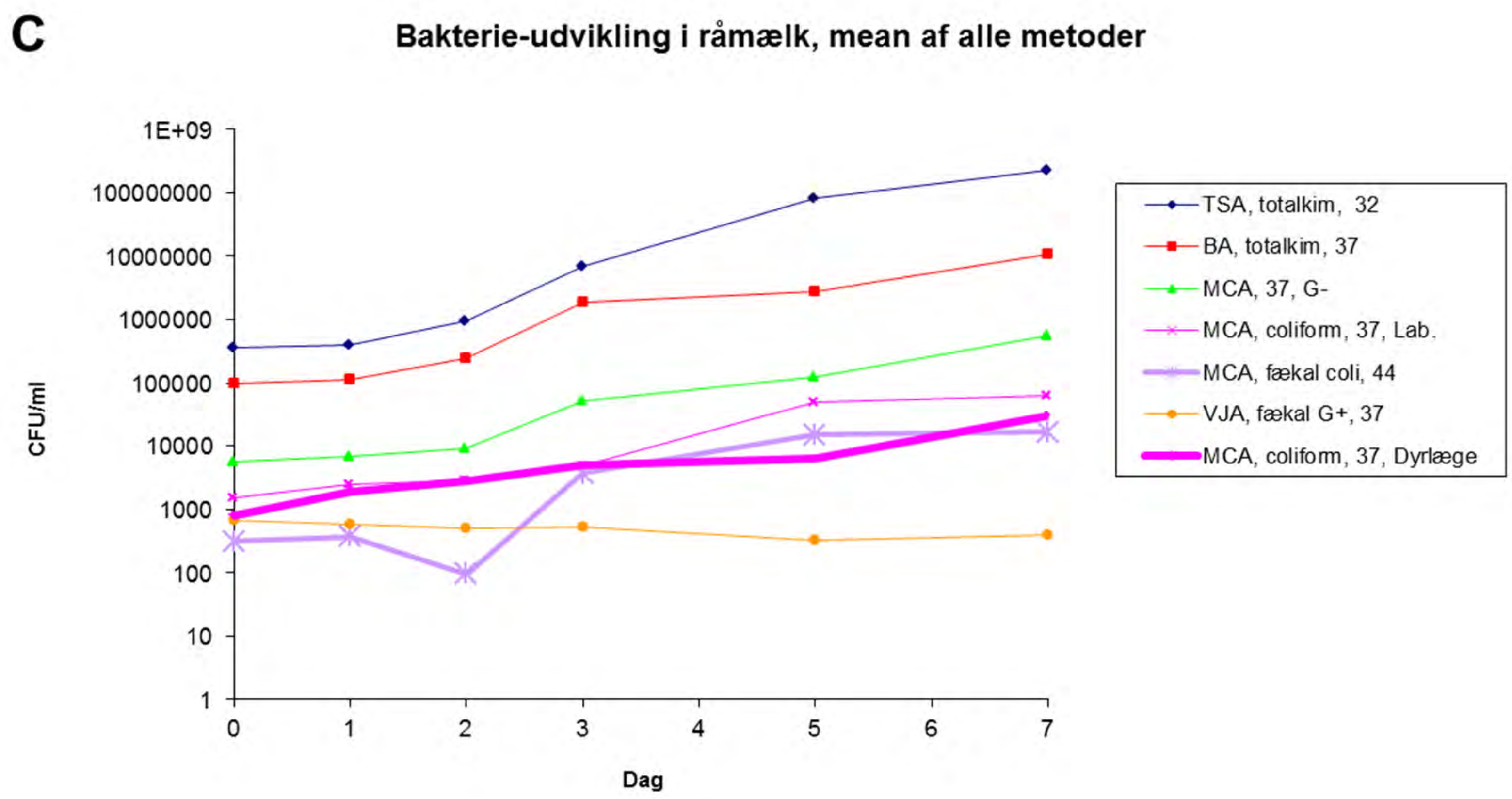


CCP7/8: Way of thawing?
How long in different system?

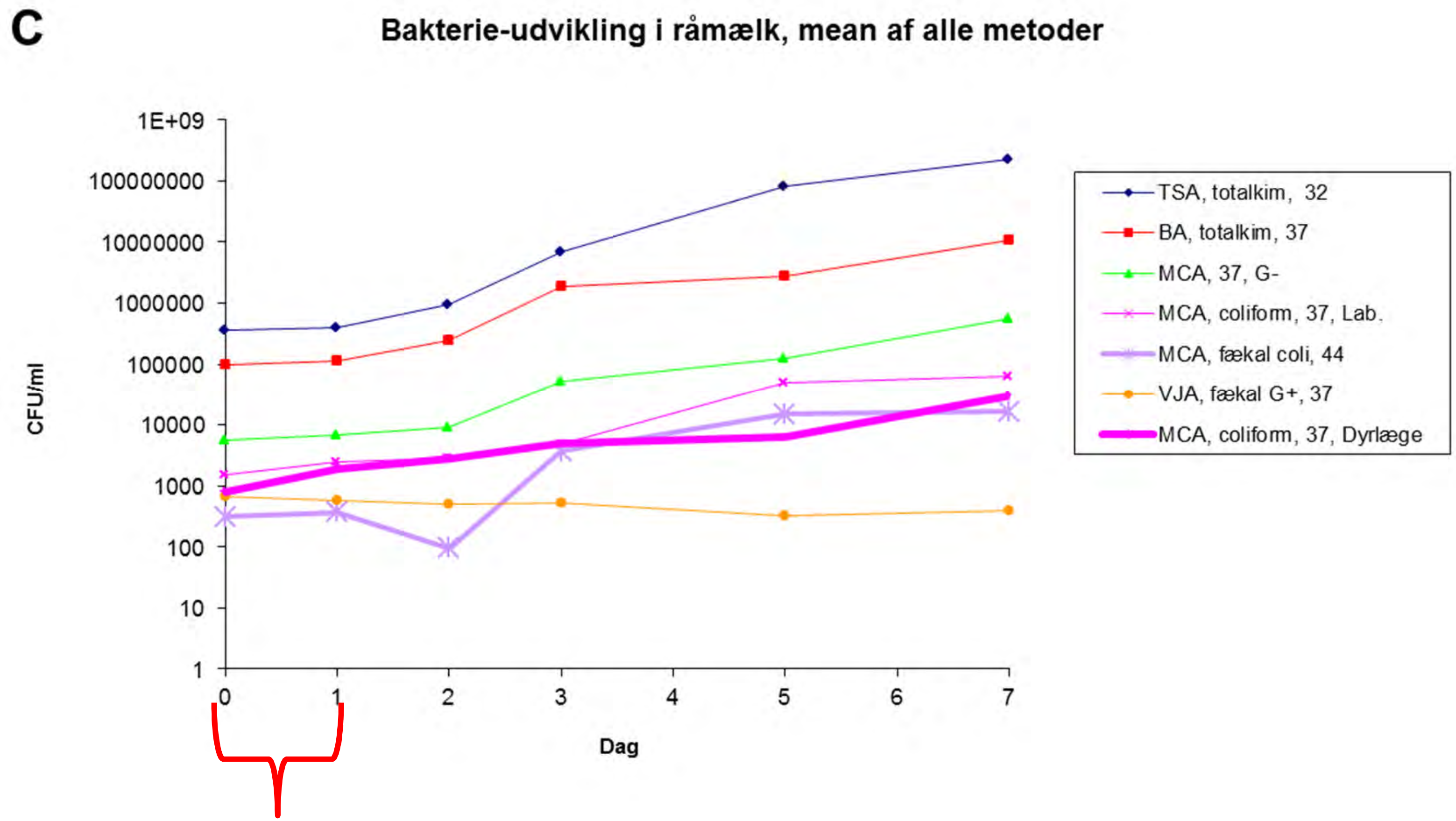


Days vs Hours vs Minutes

CCP7: Long-term thawing of frozen colostrum in the refrigerator

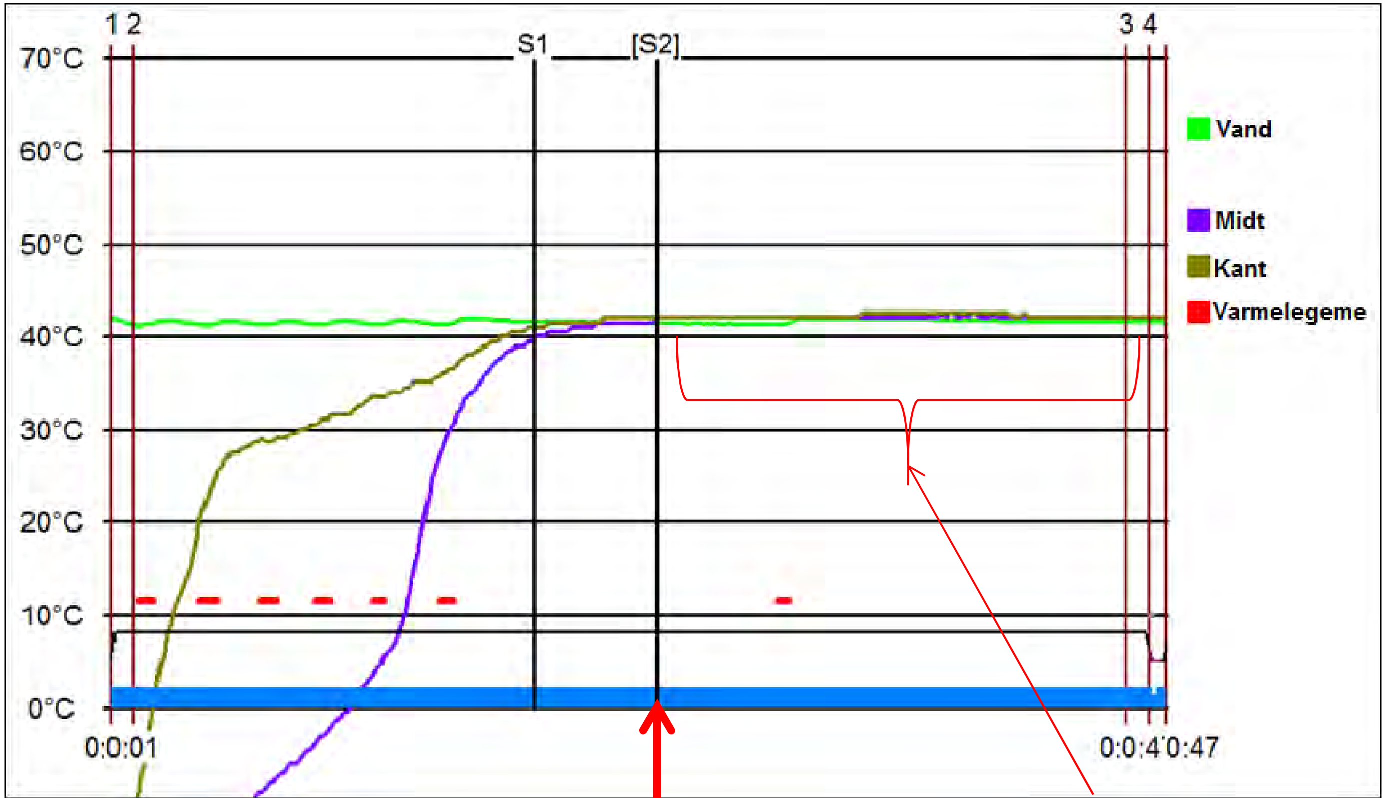


CCP7: 4 h max - & NO GO if you have a hygiene problem



CCP7/8 combined 20 min thawing & heating in the coloQuick system

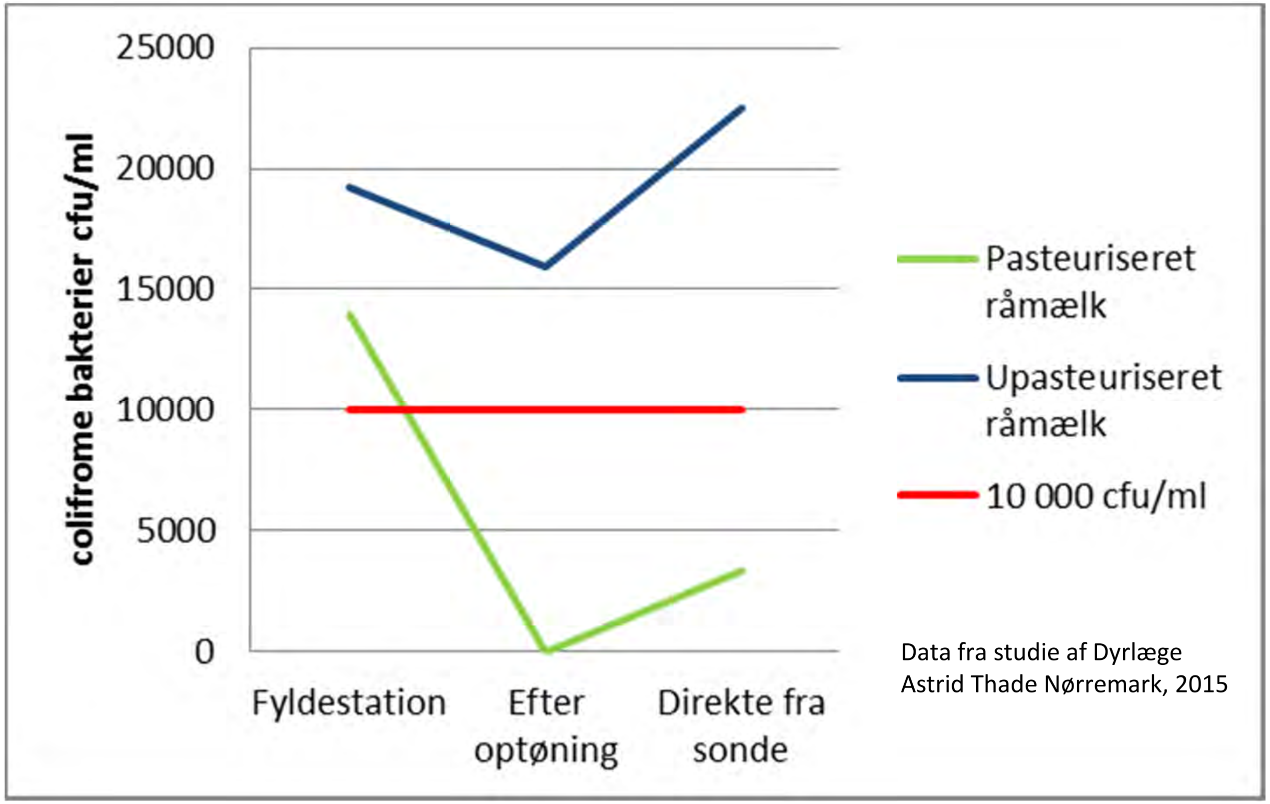
S1: 40 ºC S2: 42 ºC



Alarm

When did the farmer collect the thawed bag?

CCP6/7/8: Effect of freezing combined with 20 min thawing & reheating in a rotating water bath - coliform count



CCP6 – 42^{o}C feed heating

- How do you obtain 42^{o}C varm colostrum (commercial system vs own solution)?
- For how long do you heat at 42^{o}C?
- In commercial systems:
- Do you use the alarm on the system?
- Do you know you can use the LOG system for checking actual heating time for previous samples?

CCP5: 60ºC bag heating systems

Why do they heat treat at 60ºC and not 63ºC?

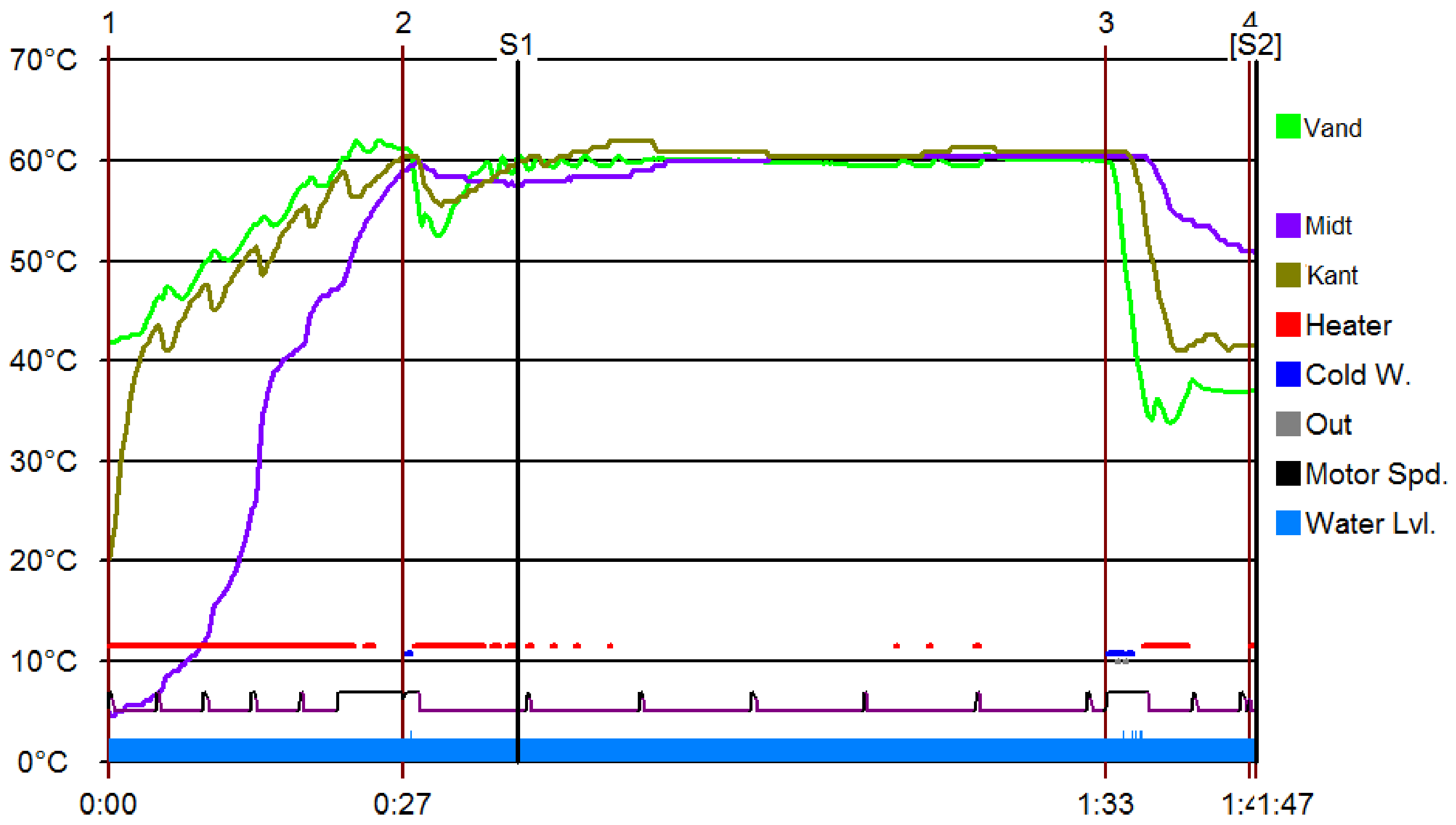
Heat treatment kills the majority of heat-sensitive bacteria, but not-heat resistent bacteria

Danish: http://coloquick.com/coloquickus/pasteurisation.aspx

German: http://www.foerster-technik.de/website/en/products/calves/colostrum_management.php

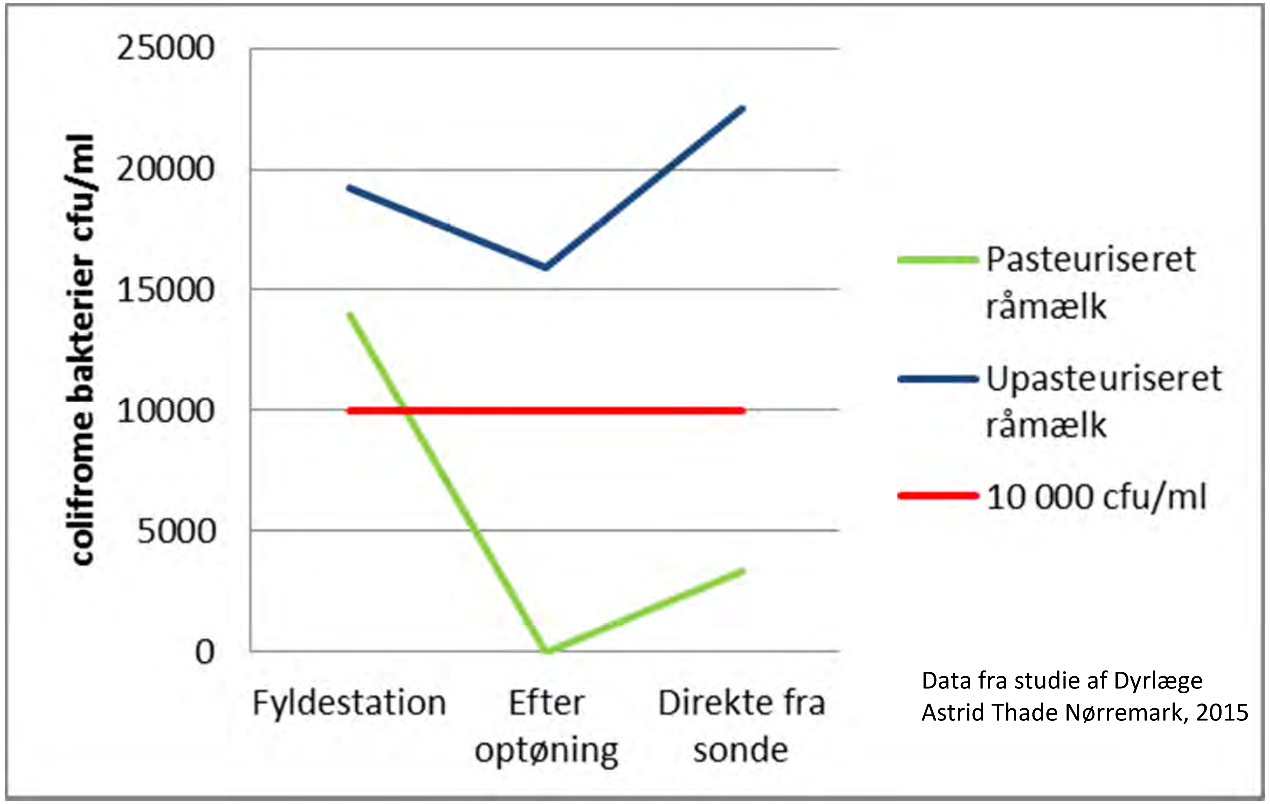
US: http://dairytechinc.com/milkworks-colostrum-rapid-warming-system

CCP5:Total and actual heat treatment period



ColoQuick Pasteur system from Calvex

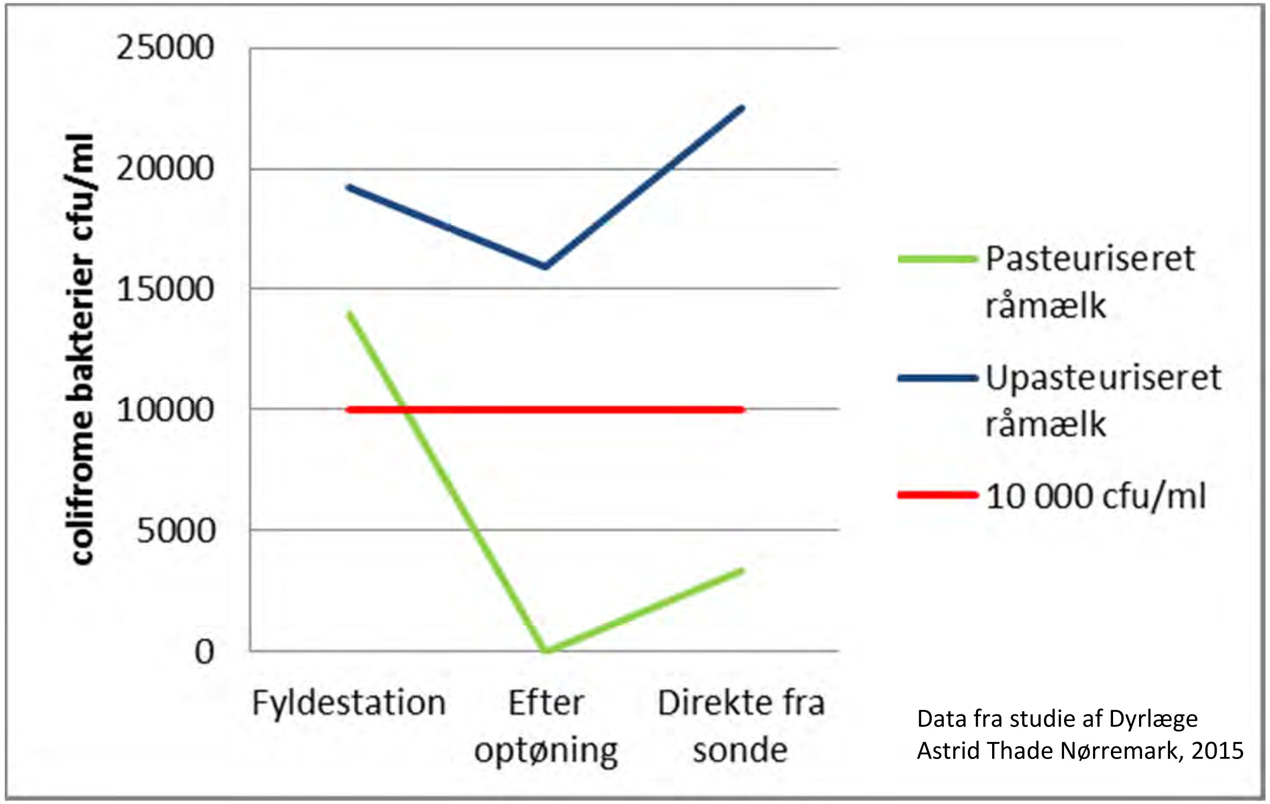
CCP5: Heat treatment of colostrum, 60°C, 60 min on coliform counts



CCP5 – Heat treament questions?

- Which commercial heating system do you use?
- What temperature do you use and for how long?
- What is the temperature in the feeding system's water bath during treatment?
- Is the water connected to a cold or hot water supply at the farm – if warm what temperature does it have?
- How sofisticated is the system (PLC?) Do the system have temperature sensors and a LOG system?
- What is the actual temperature of colostrum during heating?
- Is the colostrum bag covered entirely by water during treatment (air in the bag)?
- Is the water level in the heat system automatically adjusted?
- Are all the heat sensistive bacteria killed in colostrum (Gram-, coliforms)?
- What is the activity of alkaline phosphatase (AP) before and after heat treatment?
- How often do you clean the system and how?

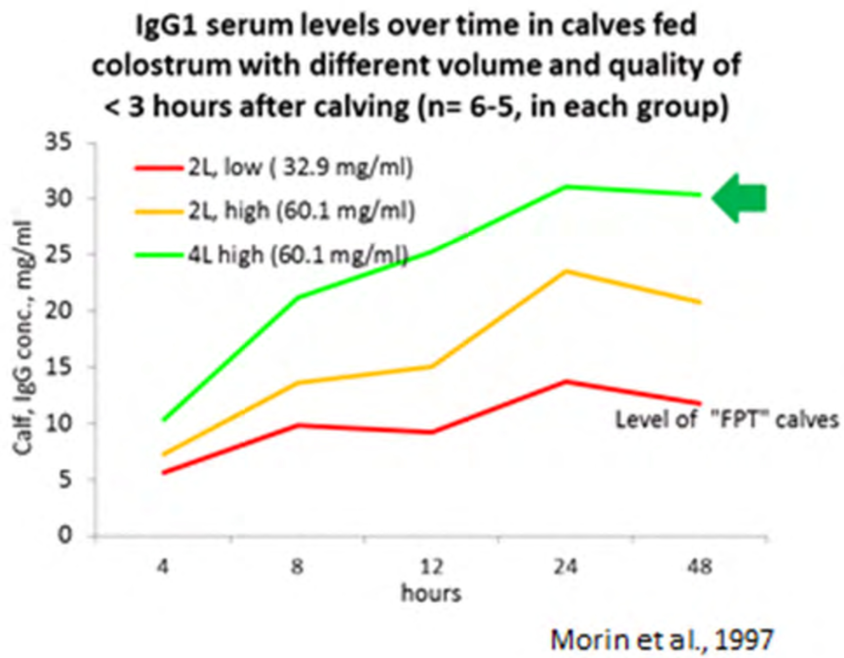
CCP9: Contamination & recontamination of colostrum by feeding



Can recontamination occur after heat treatment?
YES, but the final bacteria level will be lower .....

The calf - the proof of good or pour colostrum management

The effect og volume & IgG quality



%Calf mortality & morbidity & number of antibiotics treatments

10 CCPs in one
Colostrum feeding system

Do the farmers follow the guidelines of the available systems?

Conclusions

- Time of feeding most critical parameter/CCP > quality> volume>temperature.
- Time of feeding and quality are the most critical parameters – but can the dairy calf and cow handle it alone?
- 9-10 critical CCPs where the farmer can ruin his colostrum – if he e.g uses is own storing solution.
- Colostrum feeding systems reduce the CCP-variations in handling & chances of mistakes – but only if you follow the guidelines.

Introduction to ”home work” on colostrum management

Calf health seminar

September 21-22, 2016

Cmr Ed4. 10.10.2016

Home work assignments

- 14 vets
- 5 topics
- 4 groups x 3 students + 1 group x 2 students
- Each group coordinate their observations and data at the next calf seminar
- Each group has a 10-12 min presentation at the calf health seminar on November 16, 2016
- Each group bring all their raw data on a file on Nov 16/or send it to cmr@cmr-on-site.dk
- All farms/14 vets data will be presented by CMR/HLM on the final calf seminar in 2017

Topic flow chart

Herd recordings for all students and topics

Topic 1 – Colostrum feeding time and staff

Topic 2 Colostrum Quality: Volume, temperature & IgG

Topic 3 Colostrum Quality: Bacteria & contamination

Topic 4 Colostrum Quality: Desinfection

Topic 5 Calf health (FPT) & total serum protein

Topic work load of students

- + Herd recordings for all students – for all 5 topics - **no hands on**
- + Topic 1 Colostrum feeding time and staff - **no hands on**
- ++ Topic 2 Colostrum Quality: Volume, temperature & IgG
- +++ Topic 3 Colostrum Quality: Bacteria and contamination
- +++ Topic 4 Colostrum Quality: Desinfection
- ++ Topic 5 Calf health (FPT) & total serum protein

Home work assignments - Goals

- Recordings from 14 x 2 farms with high and low calf mortality and calf morbidity
- Overview & status in these farms
- Are the findings as we expect terms of calf health and colostrum management in the two groups of farms?
- Can we transfer knowlegde from the succesful farms with low calf mortality and morbidity to the farms with high calf mortality and morbidity based on improved colostrum management?
- Any association between % of calf and cow mortality on the farms?

For all 5 topics (skema 6)

- Each student in the group conduct a study in two dairy herds
- Select one farm with yearly high and low calf mortality and morbidity, respectively that do recordings of milking, colostrum feeding and Brix% at calving.
- Record the yearly % of calf mortality (+/-stillbirth) and morbidity
- Collect data for the average birth and weaning weights of the two gender of calves (yearly or ≥5) in the farm
- What is the average yearly milk yield per cow for each farm?
- What is the average yearly bulk milk SCC and TBC (total bacteria count)
- What is the yearly cow mortality on farm and culling%?

Topic 1 – skema 1 & 7
Colostrum feeding time & staff

- Collect informations regarding :
- Do they use any type of calving alarm?
- The time of calving & time of colostrum feeding **(5-10 cows/calves).**
- If the same person is responsible for collecting the colostrum (milking the cow) and feeding the colostrum.
- How many people that are generally involved in the colostrum feeding.
- If the cows always are milked before the calves are fed.
- If the farmer using any colostrum/feeding management system? If yes record which one (www.coloquick.dk).
- Is the farmer following the guidelines for the feeding equipment or has it been altered to match the daily rutines?
- The average farmer recorded Brix% of colostrum

Skema 1 & 7 – Questions to answer

- Answer the questions for **all topics** for each farm
- What is the reported and calculated time of feeding colostrum after birth?
- Is colostrum milking and feeding handle by the same person (answer by: yes, no, sometimes)?
- The number of persons involved in the colostrum feeding?
- How often the cows are milked before the calves are fed colostrum (always, sometimes, never)?
- If the farmer using any colostrum/feeding management system? If yes record which one. **(SE 1 TILFØJET SPØRGSMÅL i SKEMA)**
- Is the farmer following the guidelines for the feeding equipment (yes, partially, no)?
- What is the range and average of the farmer recorded Brix% of colostrum? Accuracy on barn Brix %

Topic 2 – skema 2 & 7
Colostrum volume, temperature & ‘IgG’

- Collect **5-10** colostrum samples (or more) from each farm
- Ask the farmer to illustrate exactly how they achieve the volume of colostrum fed – and test the volumen, and the possible variation of the volumen (**5-10 times**).
- Ask the farmers what temperature the colostrum theoretically have when they feed the calf?
- Ask the farmer to measure and record the exact colostrum temperature immediately before feeding it to the calf.
- Determine the vet Brix% for each colostrum sample twice.
- Compare your Brix% with farmers Brix % (**topic 1**)

Skema 2 & 7 – Questions to answer

- Answer the questions for **all topics** for each farm
- What is the average colostrum volume a calf is fed on each farm according to the farmer and determined by the vet?
- What are the average and variation of the real-time temperatures of the colostrum at feeding?
- What was the average colostrum Brix% on each farm determined by the farmer?
- What was the average colostrum Brix% on determined by the vets and how well can you (or your staff) reproduce each measurement?
- What is the estimated mean and variation (sd) in total amount immunoglobulins (Ig) that a calf is fed total /per kg BW on each farm?
- How many colostrum samples met the recommended scientific criteria for good colostrum quality of >Brix% 22 ~50 g IgG/L) on each farm?

Topic 3 – skema 3, 7, 8, 9
Colostrum – Bacteria & contamination

- Collect 5-10 colostrum samples from each farm immediately after calving prior to storage/feeding.
- Determine Brix % as in **topic 2**.
- Record the system/methods used for storage, thawing & feeding (bucket, bottle, bag, tubing). Do you re-use your bags?
- Collect 5-10 colostrum samples from the bucket or feeding system used for the calf immediately before the calf drinks it
- **PLEASE NOTICE:** All samples collected by the farmer or vet should be **FROZEN** at the farm including the bulk milk samples.
- Test the total plate count (TPC) on mastitis Chrom agar and the number of coliforms (CFU/ml) on McConkey agar using 100 ul and 10-fold dilutions.
- Collect two raw cooled bulk milk sample from the herd that are stored and transported with the colostrum samples.

Skema 3, 7, 8, 9 – Questions to answer

- Answer the questions for **all topics** for each farm?
- What is the bulk TBC detemined by the diagnostic lab (Eurofins) and the TPC in your bulk milk sample?
- What are the average numbers of TPC and coliforms in the colostrum after calving and on each farm?
- Report the type of principle/system used for feeding.
- What are the average numbers of TPC and coliforms in the colostrum the calves are drinking on each farm?
- How many of the cows that contributed with colostrum samples had clinical og subclinical mastitis by recording/finding?
- What do you consider to be good microbiological colostrum quality compared to guidelines made by vets, for bulk milk and dairy products?

Topic 4 – skema 4, 7, 8, 9
Colostrum & desinfection

- Identify two farms (**all topics**) that uses heat treatment (or another system) for desinfection of colostrum.
- Record which system & the principle of the desinfection system (batch, volume, rotation, treatment temperature & time).
- Collect 5-10 colostrum samples from each farm immediately after calving prior to storage. Determine Brix % (**topic 3**).
- Collect 5-10 colostrum samples immediately after heat treatment & the same 5-10 colostrum samples again after thawing and/or immediately before the colostrum enters the calfs mouth (**topic 3**).
- Collect two raw cooled bulk milk sample from the herd. One is heat treated in the colostrum system and one is not. The milk is sampled stored and transported with the colostrum samples.
- **PLEASE NOTICE:** All samples collected by the farmer or vet should be FROZEN at the farm including the bulk milk samples.

Skema 4, 7, 8, 9 – Questions to answer

- Answer the questions for **all topics** for each farm
- How effecient was the desinfection of bacteria (TPC and coliforms) in the bulk milk and the colostrum by the heat treatment system on the two farms?
- How high was the TPC & number of coliforms immediately before feeding?
- Were there any recontaminations of the heat treated colostrum and milk?
- If thawing what type of system was used for the samples?
- What type of bacteria were present after the heat treatment?
- How high was your TPC compared to the farmers recorded bulk milk TBC?

Topic 5 – skema 5, 7, 10
Calf health (FPT) & total serum protein

- (If time **topic 5** can be combined with **topic 1**).
- Ask the farmer for his colostrum Brix % **(5-10 samples)**
- Collect blood samples from ≥ **5-10** newborn calves (age 36-96 hours) (or 2 samples of the same calf paired: 24-36h and 96-120h)
- Record the hour-age of each calf when samples.
- Collect serum in two sterile tubes: use one tube for testing and save one sample in the freezer.
- Determine the total protein (TP) concentrations in serum by a serum refractometer in the two calf groups. Determine the value in each sample twice.
- If possible repeat the TP serum testing by a second person (vet or technician).

Skema 5, 7, 10 – Questions to answer

- Answer the questions for **all topics** for each farm
- What was the average colostrum Brix% on each farm determined by the farmer?
- What was the average serumTP and hour-age distribution for the sampled calves on each farm?
- Were the TP concentrations determined by the same person the reproduced, if not what was the variation?
- Were the TP concentrations determined by the two people reproduced, if not what was the variation?
- How many % calves met the scientific recommended guidelines of 5.2 TP g/dl ~ 8.4 sBrix% ~ total IgG 10 mg/ml (g/L) on each farm?

Sandra Godden's guidelines

Colostrum goals

IgG: > 50 g/L (mg/ml) ~ > 22% Brix

IgG total per calf: 150-200 g

Total plate count (TPC) < 100.000 CFU/ml

Total coliform count (TCC) < 10.000 CFU/ml

Serum IgG – total protein (TP) goals

FPT: serum IgG < 10 g/L (1-7 days old)

90% calves > 5.2 TP g/dl (optical refractometer)

90 % calves > 8.4 serum Brix**%**

The colostrum & milk samples and test laboratory

Calf seminar, September 21-22, 2016

By Christine Maria Røntved

Ed3. 10.10.2016

What facilities do we want in the test-lab?

- Clean and dirty +4-7ºC refrigerator
- **-18-20 ºC freezer with space**
- **≥ 1 cooler bag of good quality with a lot of cooling elements**
- **Bacteria incubator at 30 ºC (environmental milk bacteria)**
- (Bacteria incubator at 20 ºC - alternative use room temperature)
- Bacteria incubator at 37-44 ºC (cow pathogens)
- **Waterbath at 40-42 ºC** (that can be adjusted to 85 ºC)
- A sample shaker/mixer/vortexer
- A simpel kitchen water boiler
- Access to hot & cold water for cleaning
- **A table top autoclave**
- Separate garbage container for bacteriological/contaminated material and paper & plastic waste.

What type of agar, medium and reagents?

- Mastitis Aesculin blood, BD CHROM, MacConkey agar
- Brain heart infusion medium for enrichment
- Sterile 0.9% physiological NaCl
- Distilled and sterile water
- 70% and 90% ETOH
- 2% bronopol solutions for preserving the milk
- Broad spectra microtabs (http://www.gmmerc-biotech.dk/Bronopol.html)
- Your mastitis lab (KOH/Gram, katalase, Oxidase ect.)
- 9-ml testing tubes with 0.9% sterile NaCl (10-fold dilutions)
- Single use drigalski spatler
- An easy 0.1 ml and 1 ml sterile pipette solution

What type of testing equipment can help you answer your questions?

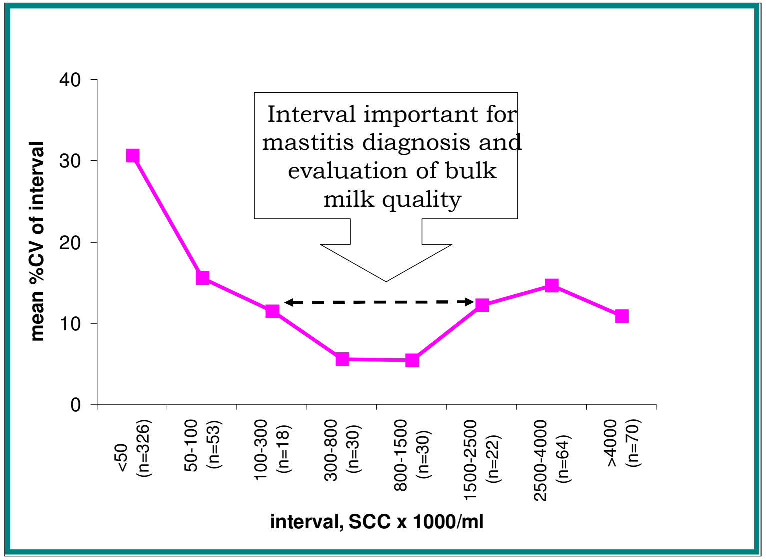
- Classical and handheld infrathermometer
- Colostrum Brix % refractometer
- Serum protein refractometer /serum Brix %
- Table top weight that goes up to 5 kg
- Handheld pH & Conductivity meter
- A portable DeLavel DCC cell counter & cassettes for SCC http://www.delaval.com/en/-/Product-Information1/Milking/Products/Milk-test--treatment/DeLaval-Cell-Counter-DCC/DCC/
- A handheld ATP/ alkaline phosphatase instrument

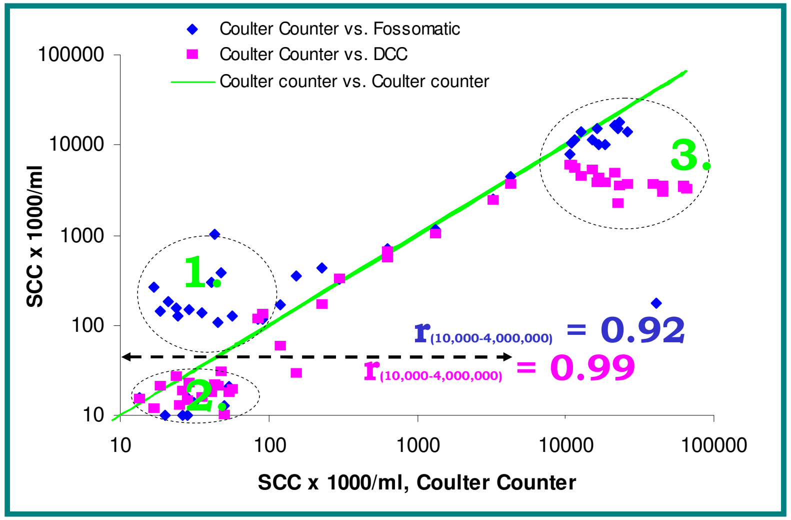
  System sure Plus Hygiena:

  Food diagnostics , Grenaa: http://fooddiagnostics.dk/kategorier/atp-loesninger/
- Small ELISA reader, ex. Kem-En-tec

Evaluation of the portable DeLaval DCC

Røntved et al., IDF, Maastricht, 2005 (poster presentation)





- **On farm and cow side test, bulk milk**
- **Measure SCC in a casette in ≤2 min**
- ***Principle:* Propidum iodide staining of cellular DNA in milk measured in a ”mini-fluorometer”**
- **Colostrum 1 milking, NO GO**

What type of test kits can help you to answer your questions?

- Colostrum quality:
  Immunoglobulin RID tests for colostrum testing
- FPT calves:
  Immunoglobulin RID tests for serum testing
- Correct pasteurisation: Alkaline phosphatase (ex. Zymosnap)
- http://fooddiagnostics.dk/produkt/zymosnap-alkaline-phosphatase-100-stk./
- Tests for proper hygiene:
  Food diagnostics , Grenaa: http://fooddiagnostics.dk/kategorier/atp-loesninger/
  ATP (ex Ultrasnap)
  Protein residues (ex Proclean swabs)
- Antibiotics in colostrum and wastemilk:
  Delvotests: BLH: 3.min cow test and 3-h: bulk milk test
  Vilofarm, Onsild: https://webshop.danishagro.dk/index.php
- Water quality : dry sticks (made for fish, pet food stores)
- Correct and efficient cow vaccination? (**ELISA**)

Sandra Godden's guidelines

Colostrum goals

IgG: > 50 g/L (mg/ml) ~ > 22% Brix

IgG total per calf: 150-200 g

Total plate count (TPC) < 100.000 CFU/ml

Total coliform count (TCC) < 10.000 CFU/ml

Serum IgG – total protein (TP) goals

FPT: serum IgG < 10 g/L (1-7 days old)

90% calves > 5.2 TP g/dl (optical refractometer)

90 % calves > 8.4 serum Brix**%**

How do we secure good sample quality?

Microbiology:

- Homogenous and representative samples
- **FROZEN** colostrum and milk samples
- Do we (vet , farmer) contaminate the sample?
- Do our equipment contaminate the samples?
- What happens during transportation in the vet. car?
- Proper thawing, heating and mixing of stored cooled and frozen milk samples in the barn and in the lab.
- Bacteria grow very fast in milk: if you samples are in **liquid** form **FREEZE** your samples!!!
- Please respect the farmer and the companies that sells milk feed and milk feed equipment and transport the frozen samples in a cooler bag.
- **Dry powder form** (no worries), take sterile sample and transport as you like.

Drymatter, fat and protein composition & SCC samples for shipping:

- Homogenous and representative samples
- Preserve you samples: Add 2% **bronpol** (1:100) to make final a 0.02% dilution in colostrum/milk

Where can I go if I need calibration and reference material for milk and blood?

Milk

Aldi: UHT (ESL) milk (sødmælk, 3.5% fedt)

Eurofins (leverer ugentlige kalibringsprøver til måleudstyr på mejerier)

- http://www.eurofins.dk/soegning/?q=milk&x=0&y=0

DRRR, Kempten, Germany

Dem Deutschen Referenzbüro für Lebensmittel-Ringversuche & Referenzmaterialien

- http://www.drrr.de/

Bovine serum/plasma:

- http://www.nordicbiosite.com/ sell Bethyl Laboratories product

Where can I go if I need an accredited milk/milk replacer analysis?

Examples of smaller-medium sized flexible labs:

AnalyTech Miljølaboratorium
http://www.analytech.dk

Nordlab Skagen
http://nordlab.dk/

ALcontrol (Filial af ALCONTROL AB in Sweden), Hellerup
http://dk.alcontrol.com/da

Examples of larger, less sample-flexible labs:
Eurofins
Fødevarestyrelsen (Aarhus): Fødevarer: kemi og mikrobiologi
https://www.foedevarestyrelsen.dk/Kontrol/Laboratorieydelser/Analyser/Sider/Forside.aspx

Most last laboratories carry out accredited and non-accredited analysis
Always ask - If the analysis is accredited it will (or should) be described in the lab. report you receive.

Where can I find/buy information about milk standards?

Danske standard (DS) (DS/ISO/IDF standards)

http://www.ds.dk/da/

The International Dairy Federation (IDF)

http://www.fil-idf.org/Public/ColumnsPage.php?ID=23077

Where can I go if I need an accredited water analysis ?

- Analytech miljølaboratorium, Nørresundby (varetager stor dele af alle vandværker i Jylland samt badevandsprøver)

  http://www.analytech.dk

- Eurofins, Agroscience Services, Holstebro;

  http://www.eurofins.dk/eurofins-steins-og-agro-testing/vores-ydelser/eurofins-agro-testing-denmark/kvaegbrug/kontrol-af-drikkevand/

- Alcontrol (Filial af ALCONTROL AB in Sweden), Hellerup

  http://dk.alcontrol.com/da

- Dansk pelsdyrfoder*, Holstebro

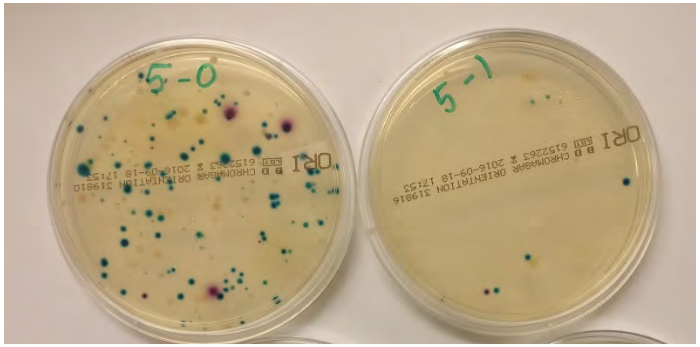
  http://www.danskpelsdyrfoder.dk/Default.aspx?ID=6

  *OBS for TPC they uses an old *expired* DS analysis for detecting Pseudomonas

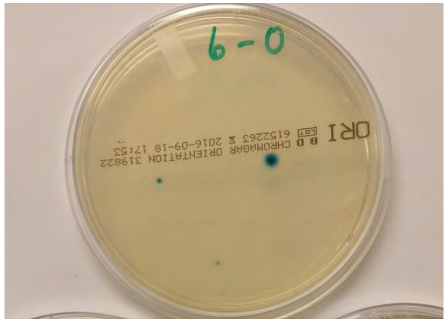
  Handout about Water Quality by David Beede, 2008, US

Can we use CHROMagar as a screening for TPC & reduction in bacteria count?

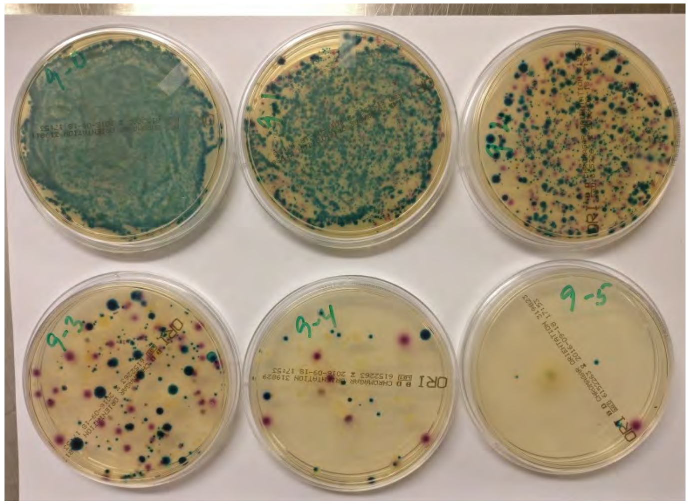
Raw bulk milk before

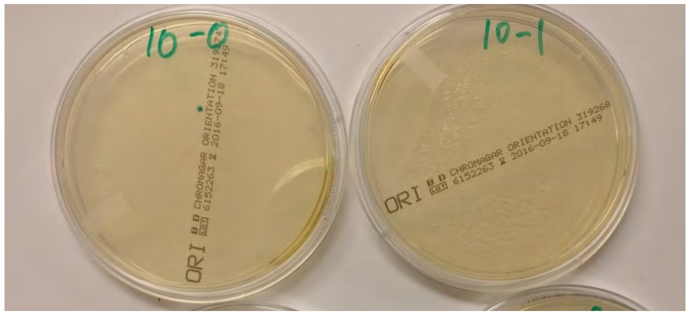


after LTLT pasteurization

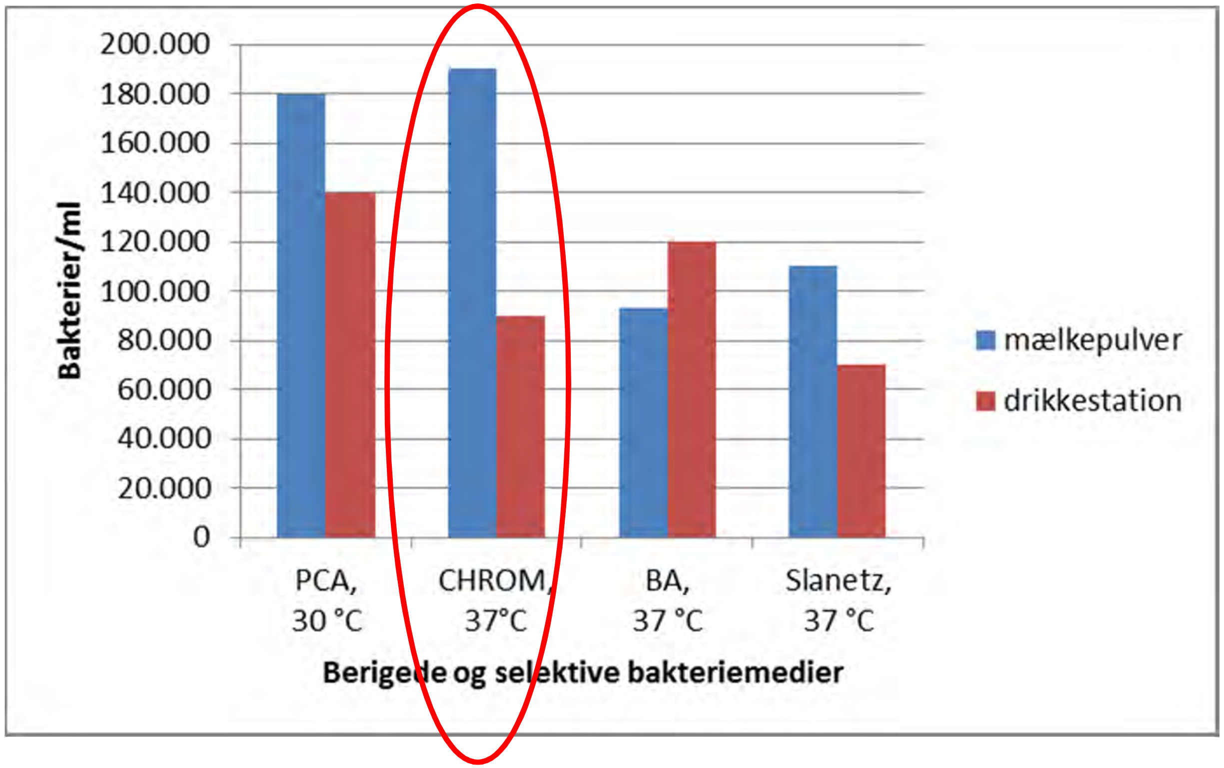


Raw bulk milk left at RT 18 h before and after LTLT pasteurization



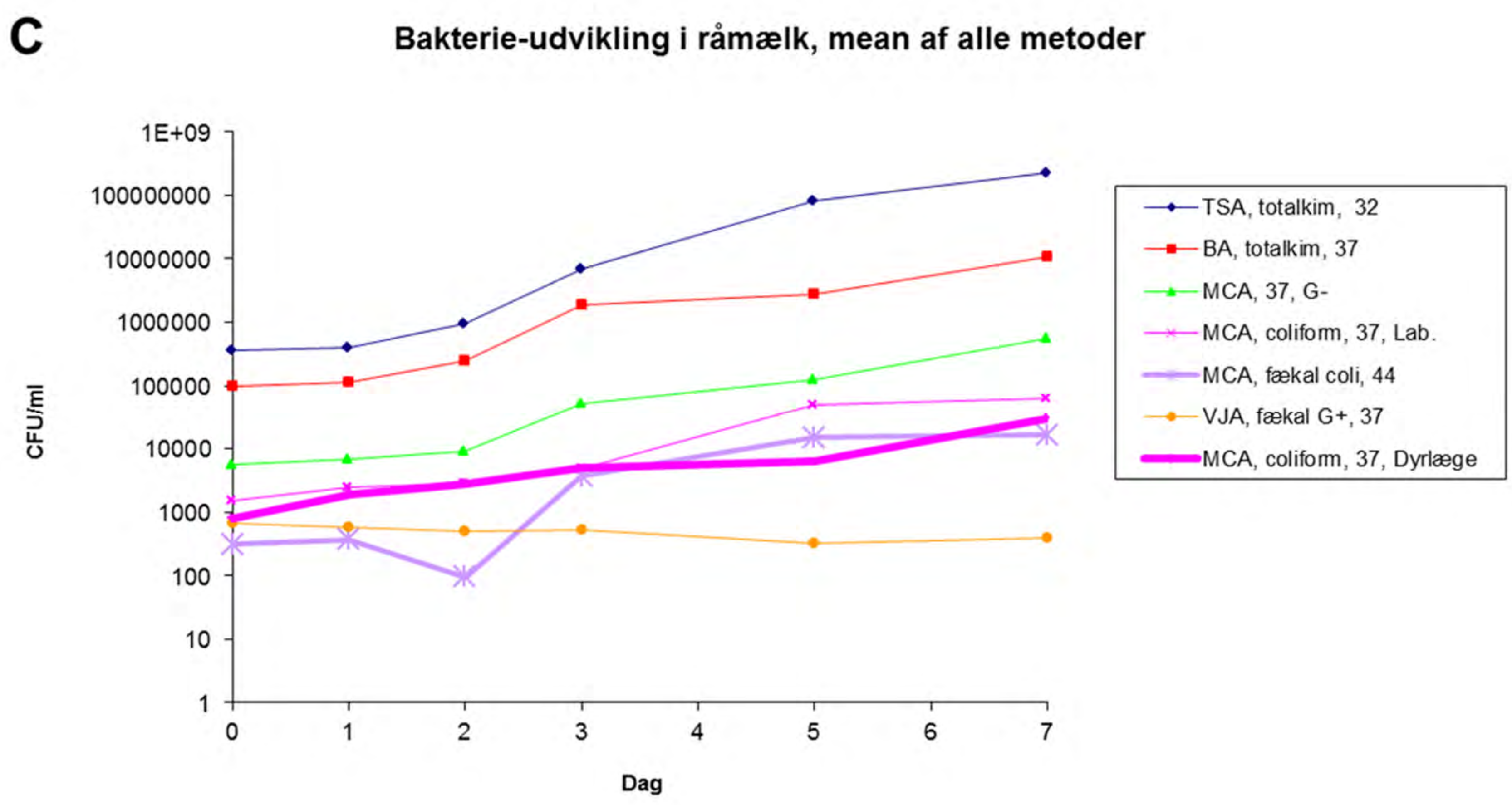


Comparing different agars for growing bacteria in a milk sample
total plate count = TPC (cfu/ml)



PCA, 30^{o}C , 72 t : standard method for total plate count (TPC) of bacteria in milk

Agar type & incubation temperature determine the number of bacteria you count in a sample



TPC and TCC findings on frozen milk samples from three Danish farms

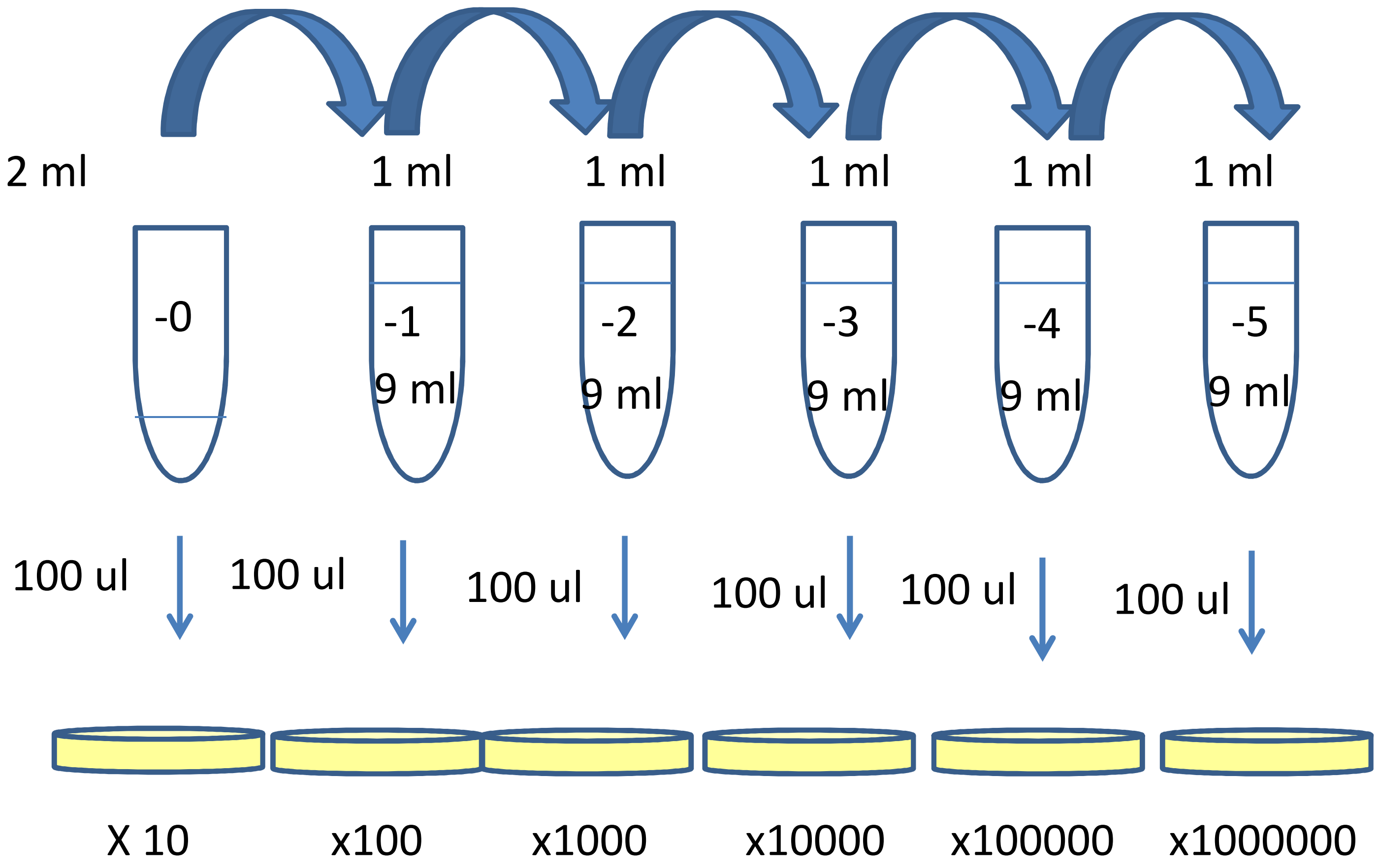
Prøve nr	Prøve-beskrivelse	Kolostrum Brix%	Timer fra kælvning til malkning	TPC målt ved M-PCA, 30 Cº, 72 t CFU/ml	TPC målt ved CHROM, 30 Cº, 48 t CFU/ml	TCC målt ved VRBL 37 Cº, 24 t CFU/ml
Grøndalsgaard						
1 22669	Tankmælk*			11000	7800	4
2 22670	Kolostrum	19,5	IA	160000	ND	ND
3 22671	Kolostrum	19,8	8-10t	900000	ND	ND
4 22672	Kolostrum	19,8	10t	280000	ND	ND
5 22673	Mælkevogn			360000	120000	<100
6 22674	Kolostrum	10,1	10t	2.700.000	ND	ND
7 22675	Kolostrum	26,5	3.45t	600000	ND	ND
8 22676	Kolostrum	IA	IA	81000	ND	ND
9 22677	Kolostrum	IA	IA	>3.000.000**	ND	ND
Kærgaard I/S						
10 22678	Pasteu. mælk (før varme behand.)			240000 pp	20000	0
11 22679	Kolostrum	IA	IA	1.400.000	320000	24
12 22680	Pasteu. kalvemælk udfodring (efter varmebeh.)			280000	300000	0/4200***
Frode Staun						
13 22681	Syrnet kalvemælk*			230000	470000	4800
14 22682	Syrnet kalvemælk*			1.500.000	1.880000	16000
15 22683	kolostrum	17	IA	140000	110000	1600
16 22684	kolostrum	17	IA	590000	320000	9000
17 22685	kolostrum	16	IA	42000	50000	2400
18 22686	kolostrum	20	IA	930000	490000	300

*modtaget kølet ** CFU-tal for højt til at kunne tælles I den højeste valgte lab-fortynding
*** CFU/ml ved 36 timer med + vækst senere i lab.
IA: ikke angivet ND: ikke udført pp: mange små pinpoint kolonier kun talt på MPCA og ikke på CHROM

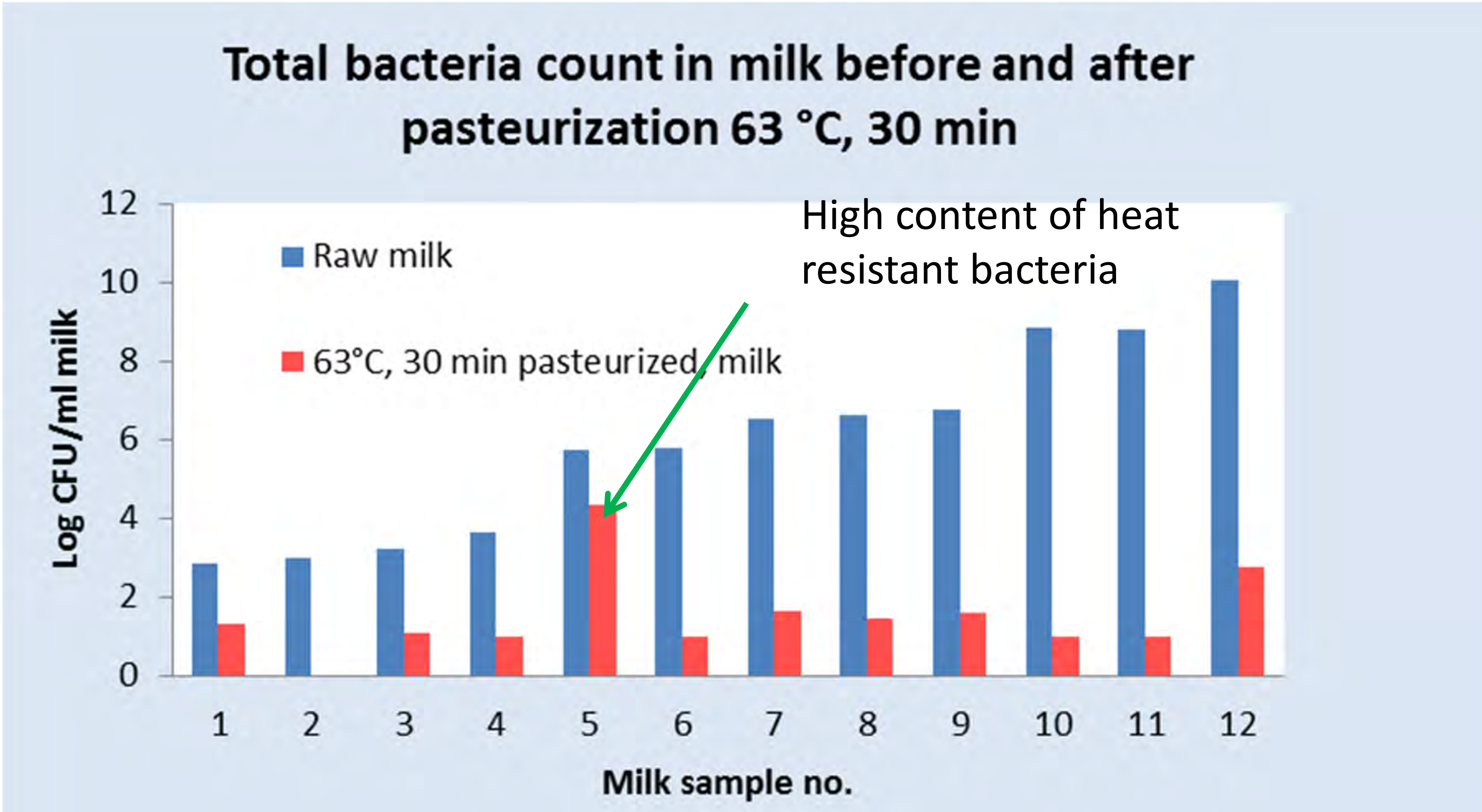
Simpel unofficial vet. protocol for growing bacteria in colostrum & milk

- Step 1 Thaw your milk sample and mix it gently by hand at least 10 times
- Step 2 Use BD mastitis CHROMagar plates that have room temperature
- Step 3 Make a 10-fold 0.9% saline dilution of your milk sample: 9 ml saline + 1 ml milk (see dilution number and principle on next slide)
- Step 4 Add 100 ul of the milk or diluted sample to your CHROMplate & spread it with a Drigalski spatel.
- Step 5 Incubate your samples in an incubator at 30ºC, 48 hours.
- Step 6 If you expect many psycrotrophic bacteria or yeast/mold incubate an additional samples at 20ºC, 96 hours at room temperature (RT)
- Step 7 Calculate the number og bacteria on at least 2 plates (2 dilutions) or duplicates samples in same dilution
- You may LOG transform your data. Obs. you need **at least** 0.5 log to have a difference of importance between your samples
- **The same sample dilutions can be added to Blood Agar, MacConkey agar (Gram-) , or chosen Gram+ agar, ex Baird Parker, Slanetz or Vogel Johnson agar (VJA).**
- **Please notice these agars result in lower counts than on PCA and CHROM**

Principle of 10-fold dilutions on CHROM counting CFU/ml

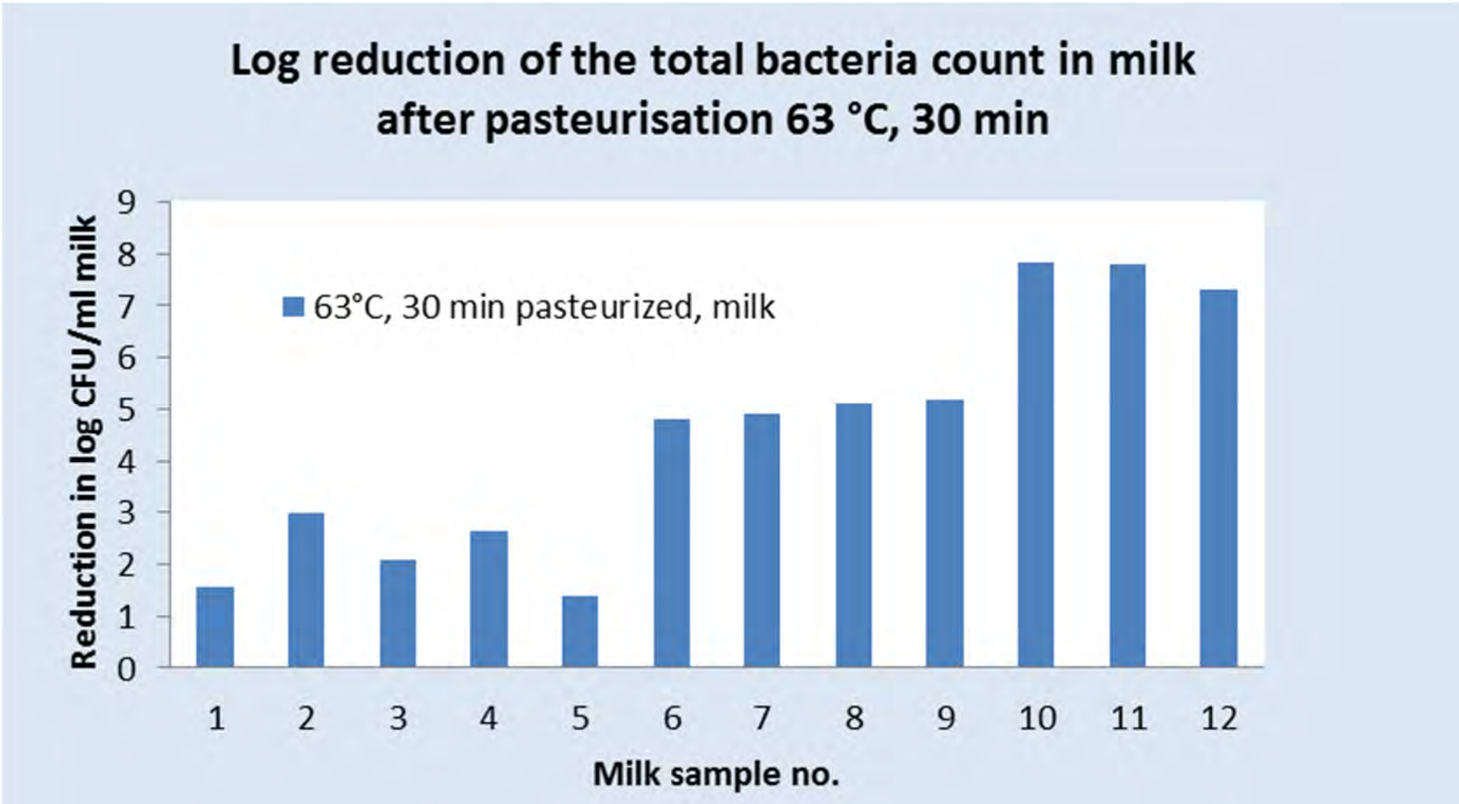


Pasteurization of milk 63^{o}C, 30 min counted on CHROM agar, 30^{o}C 48 t



High effiency in killing of heat sensitive bacteria

Pasteurization of milk 63 °C, 30 min
LOG reduction on CHROMagar, 30°C 48 t



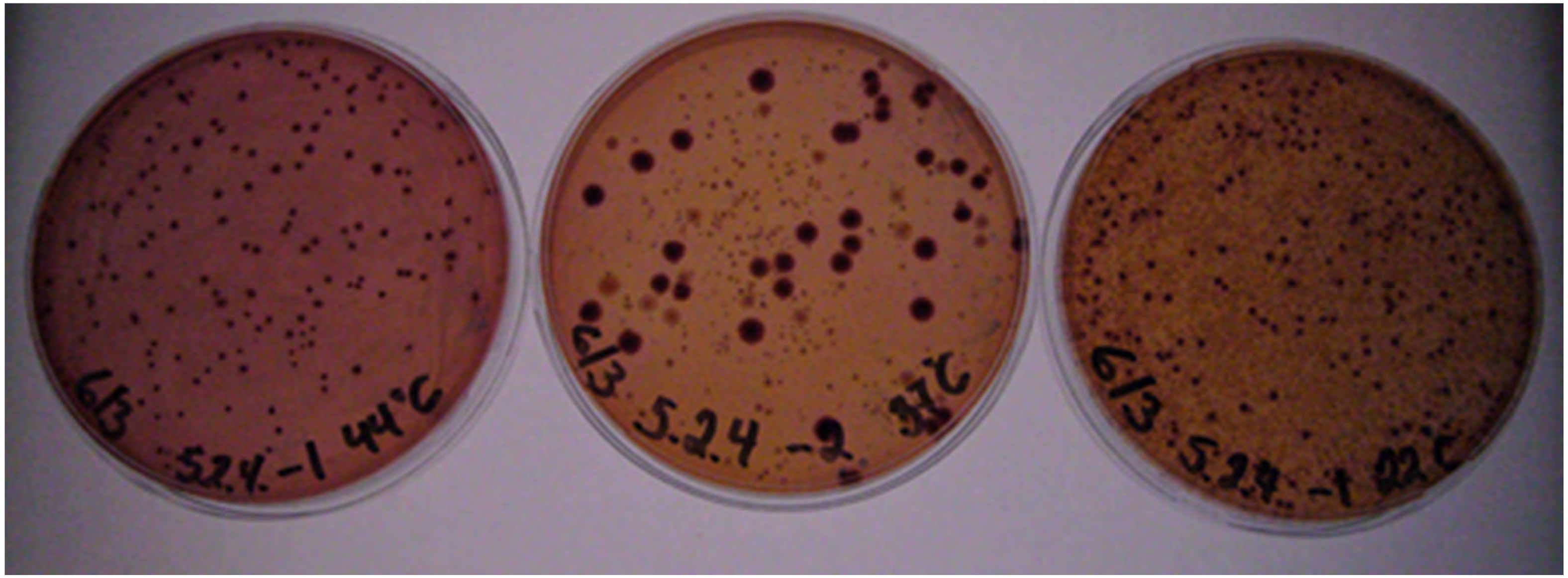
Quality control of calf milk solutions
What do I recommend?

- Bulk milk – YES
- Waste milk - YES
- Pasteurized milk and waste YES
- Milk replacer if added probiotic bacteria NO – get samples analysed by an accredited laboratory
- *Milk replacer if no probiotic bacteria YES

Milk replacer = milk powder + water + feeding system/equipment

*Keep it as a **TPC, coliforms (TCC)** for screening for hygiene & low pasteurisation) screening and remember your method might not detect the heat resistant bacteria e.g. endospores . If you suspect pathogenic bacteria send it to an accredited laboratory

Growth of coliforms (pink) and other bacteria (white-yellow) on MacConkey agar



Different types of milk samples
How many 10-fold dilutions?

- Colostrum
- Fresh bulk milk
- Transition milk
- Mastitis milk
- Acidified milk
- Milk replacer
- Milk replacer with probiotics

Colostrum CCP and CFU/ml guidelines

Udder before milking

milking maschine bucket

ColoQuick volume station

ColoQuick heating and thawing system

Feeding euipment

Ready to feed at calf mouth

Where can I go if I experience ”strange” problems with my lab. equipment or analysis?

DVM, PhD Christine Maria Røntved

-Your Veterinay RD expert in Livestock, Food- & Animal by-Products & Technologies

Cmr On-site RD
Institute for Physics and Nanotechnology, Postbox 68
Skjernvej 4A
DK-9220 Aalborg East
Denmark

CVR/SE no.: 33 51 56 93
E-mail: cmr@cmr-on-site.dk
Phone: **+45 25 32 16 61**
https://www.linkedin.com/in/cmronsiterd

CMR On-Site

Nutritional Management of Preweaned Calves

Sandra Godden DVM, DVSc
University of Minnesota
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Key Management Areas for the Youngstock Program

- Dry cow management
- Maternity pen management
- Care of newborn calf
- Colostrum management
- **Preweaning nutrition**
- Housing and sanitation
- Disease diagnosis & treatment
- Pain management

Plane of nutrition in affects…

- Calf:
  - Growth
  - Ability to cope with cold stress
  - Immune function / health

- Adult cow:
  - Age at first calving
  - Milk production
  - Longevity
  - Lifetime economics

- Goal: Double birth weight by 56 days of age

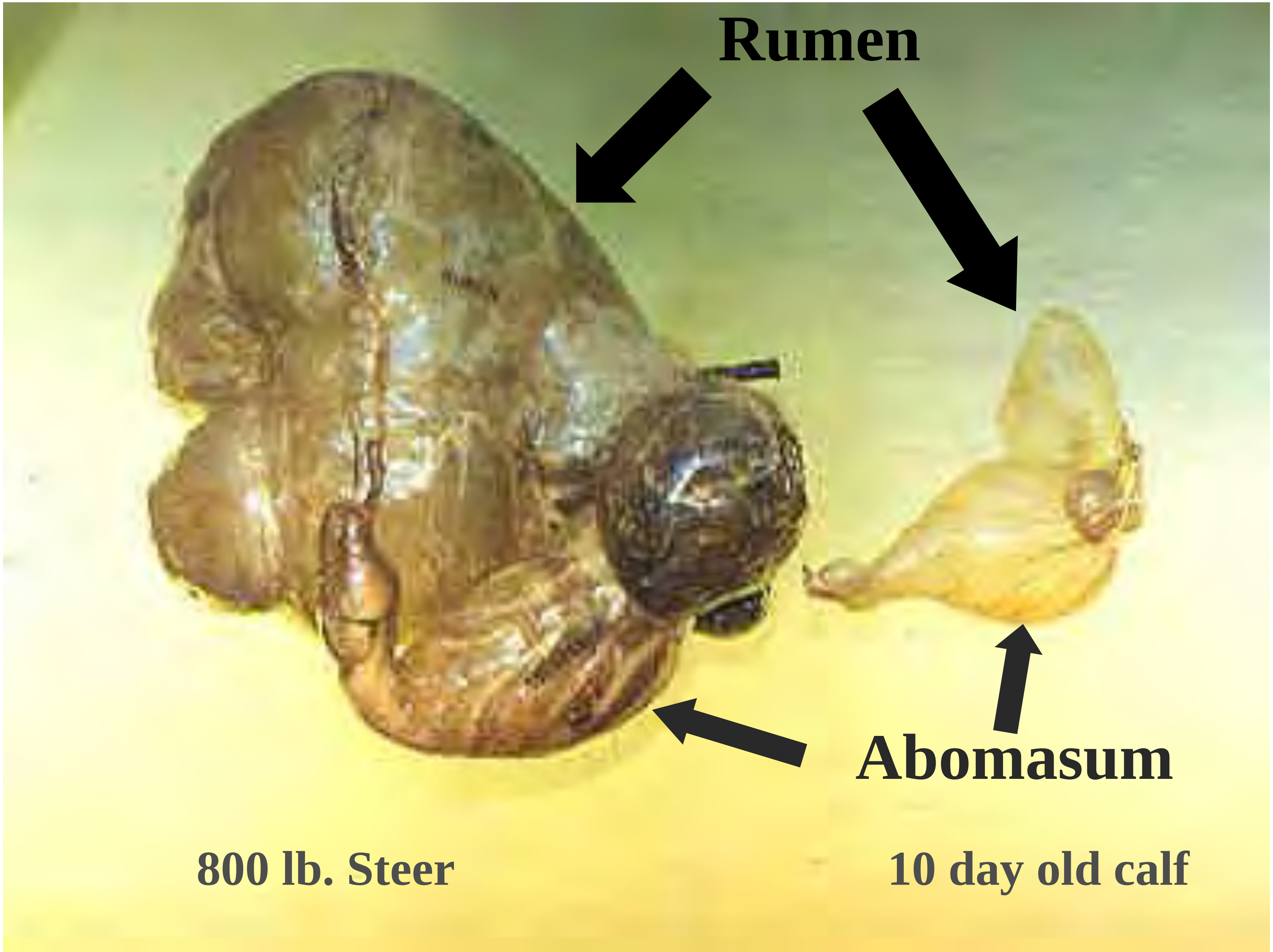
  40 kg BWt => 80 kg at weaning

  (ADG = 0.71 kg/day or 1.6 lb/d) (Van Amburgh, AABP,

Calf Nutrition from birth to weaning - Outline

- **Rumen development**
- Protein and Energy requirements:
  – Growth
  – Health
- Liquid feeding programs
- Starter management
- Water management
- Weaning strategies

Rumen Development



Three Phases of Calf Rumen Development

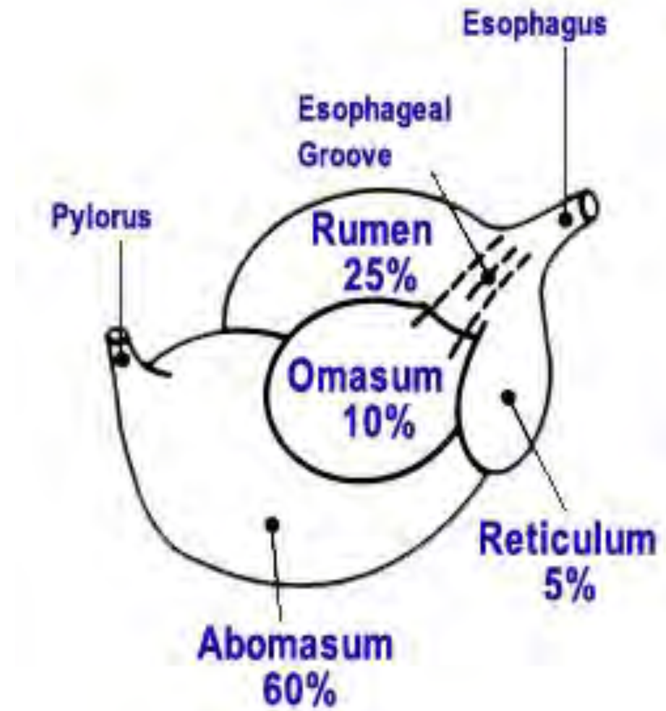
– Pre-Ruminant Phase
    • Birth – 3 to 4 weeks

– Transition Phase
    • Normally 3 to 4 weeks to weaning

– Ruminant Phase
    • Weaning to 225 lb and beyond

Pre-Ruminant Phase
3 to 21-28 days of age

- Baby calves do not have:
  - a functional rumen
  - cannot digest solid feed
  - limited rumen capacity
- Abomasum is the main compartment involved in digestion
- Dependent on liquid diet for nutrients
- Diet: Milk or high quality milk replacer, calf starter, water



Week 1


11
12
0 mm 10 20 30

Transition Phase
3-4 weeks to weaning

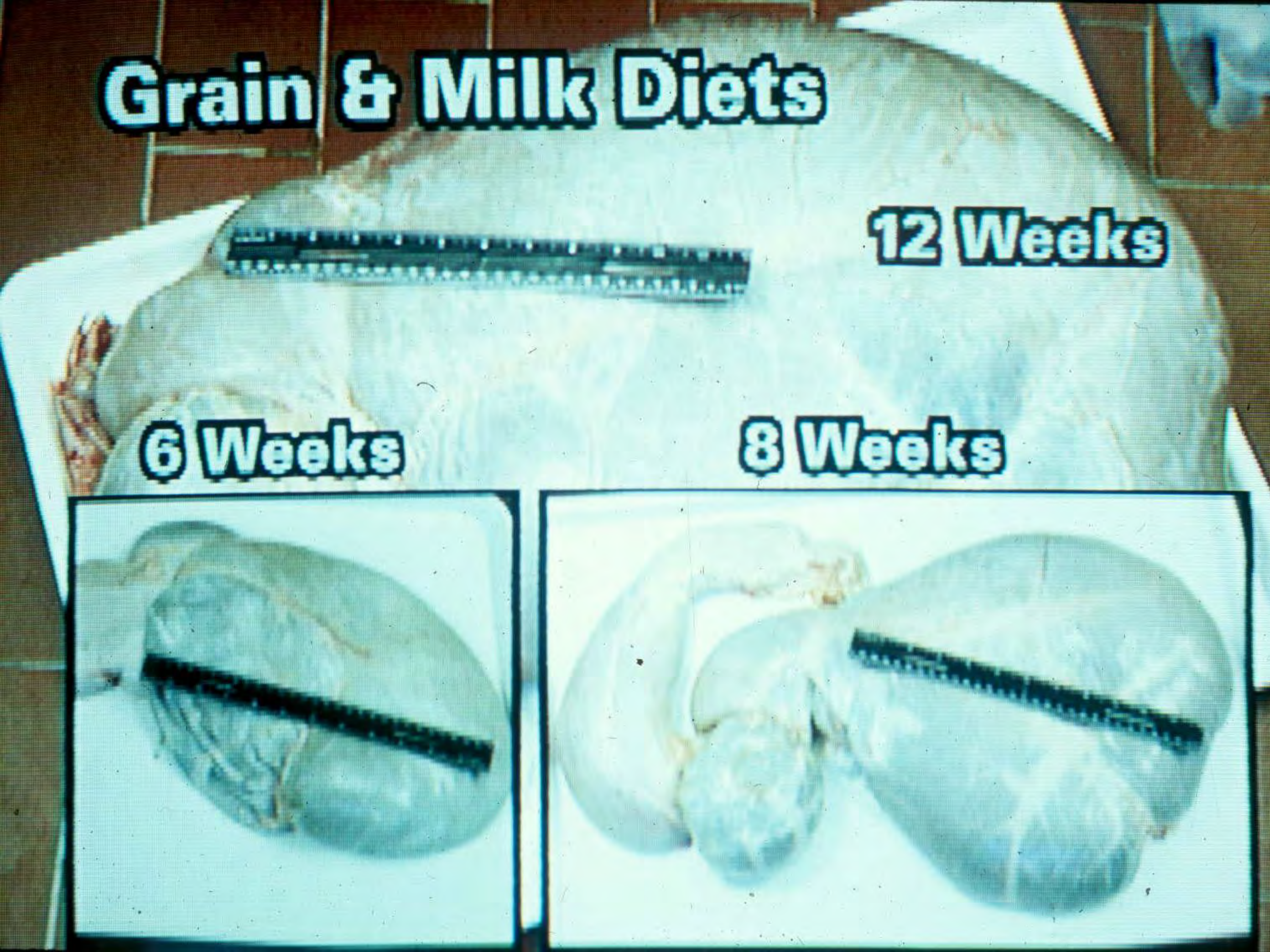
- Begin developing a functional rumen capable of digesting dry feed (starter pellet)
- Takes a minimum of 3 weeks, but continues as long as milk is fed
- Rumen development accomplished by grain feeding to promote butyric and propionic acid production, lowering pH and increasing bacterial growth:
  - Size
  - Muscularity
  - Papillae
  - Bacteria, protozoa

Rumen papillae

4 weeks old
- milk fed

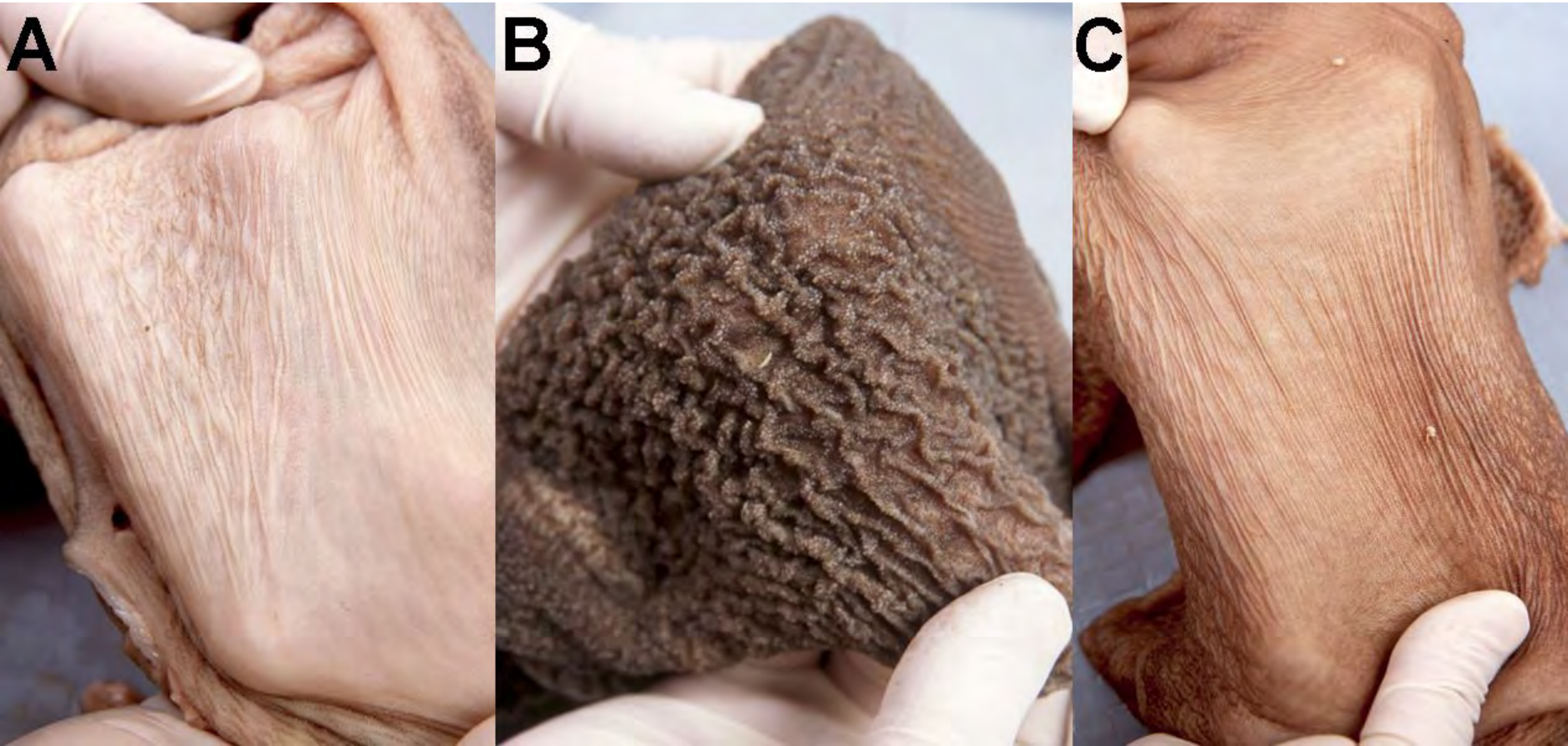
4 weeks old
- grain and milk fed


4 Weeks
Milk
Only
8 Weeks
Milk
Only
12 Weeks
Milk
Only


Grain & Milk Diets
12 Weeks
6 Weeks
8 Weeks

Rumen papillae development in 6 week old calves fed 3 different diets

Milk Only **Milk and Grain** **Milk and Hay**



Forages (e.g. dry hay) are generally not recommended prior to weaning because…

- Microbes are not initially capable of fermenting forages
- Forage fermentation results in acetic acid production => does NOT promote rumen development
- Creates rumen fill, displacing calf starter without promoting rumen development
- Small amounts of forage (<15% of DM) are OK;
  - E.g. fine chopped hay mixed with grain

Ruminant Phase

Weaning to 225 lb and beyond

- After 3-4 weeks in the transition phase, a well developed rumen should allow calf to efficiently digest grains
- Milk (liquid) diet is discontinued:
  - wean at 7-9 weeks
- Diet:
  - 1-2 weeks post-weaning = grain, water
  - 3+ weeks post-weaning = grain, water, forages

Calf Nutrition from birth to weaning - Outline

- Rumen development
- **Protein and Energy requirements:**
  - **Growth**
  - **Health**
- Liquid feeding programs
- Starter management
- Water management
- Weaning strategies

- Question:
  What are your calf's protein requirements?

- Answer:
  It depends on your target rate of gain

- Goal: Double birth weight by 56 days of age
  40 kg BWt => 80 kg at weaning
  (ADG = 0.71 kg/day or 1.6-1.8 lb/d)
  (Van Amburgh, AABP, 2009)

Updated Nutrient Requirements for a 45 kg Calf Under Thermoneutral Conditions

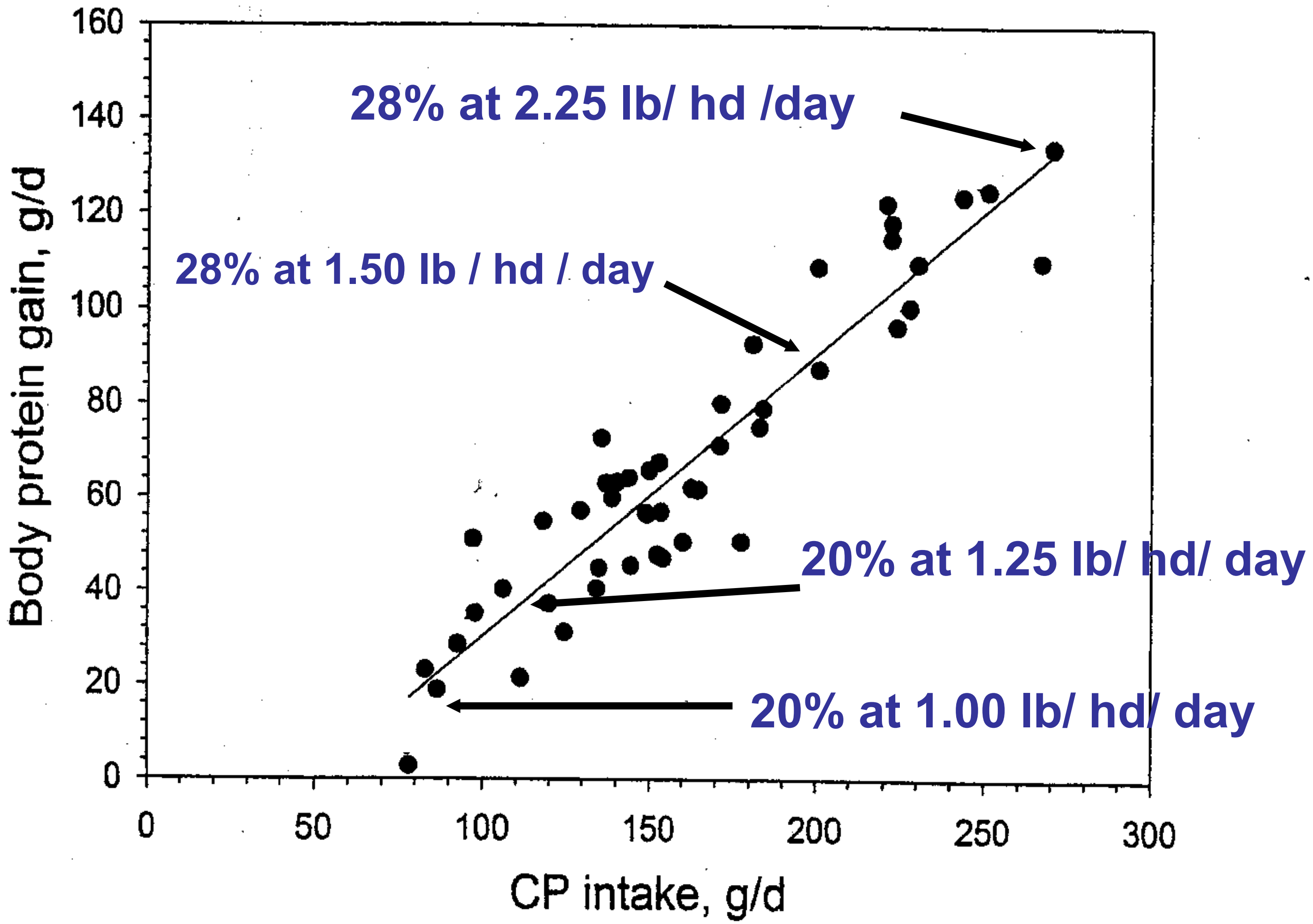
Target rate of gain, kg/d	ME[a], mcal/d	DMI, kg/d	ADP, g/d	CP, g/d	CP, % DM
0.2 *	2.35	0.50	87	94	18.0
0.4	2.89	0.64	140	150	23.4
0.6	3.48	0.76	193	207	26.6
0.8 **	4.13	0.90	235	253	27.5
1.0	4.80	1.10	286	307	28.7

* Conventional
** Full potential

Van Amburgh and Drackley, 2005

More Protein Fed = More Protein Gained

(provided energy is not limiting)



J.K. Drackley. 2005. Does Early Growth Affect Subsequent Health and Performance of Heifers ? Western Canadian Dairy Conference. Pp. 189-203.

Energy Requirements of Calves

- Dietary Sources of Energy:
  - Pre-ruminant (liquid feeding) phase: Milk or milk replacer
  - Transition phase: Combination of milk or milk replacer plus starter feed
  - Ruminant phase: dry feed
- Energy intake will affect:
  - Rate and composition of gain
  - Ability to cope with cold weather
  - Immune function:
    - Coping with stressors
    - Preventing illness
    - Recovering from illness

Body Fat Reserves at Birth are Limited

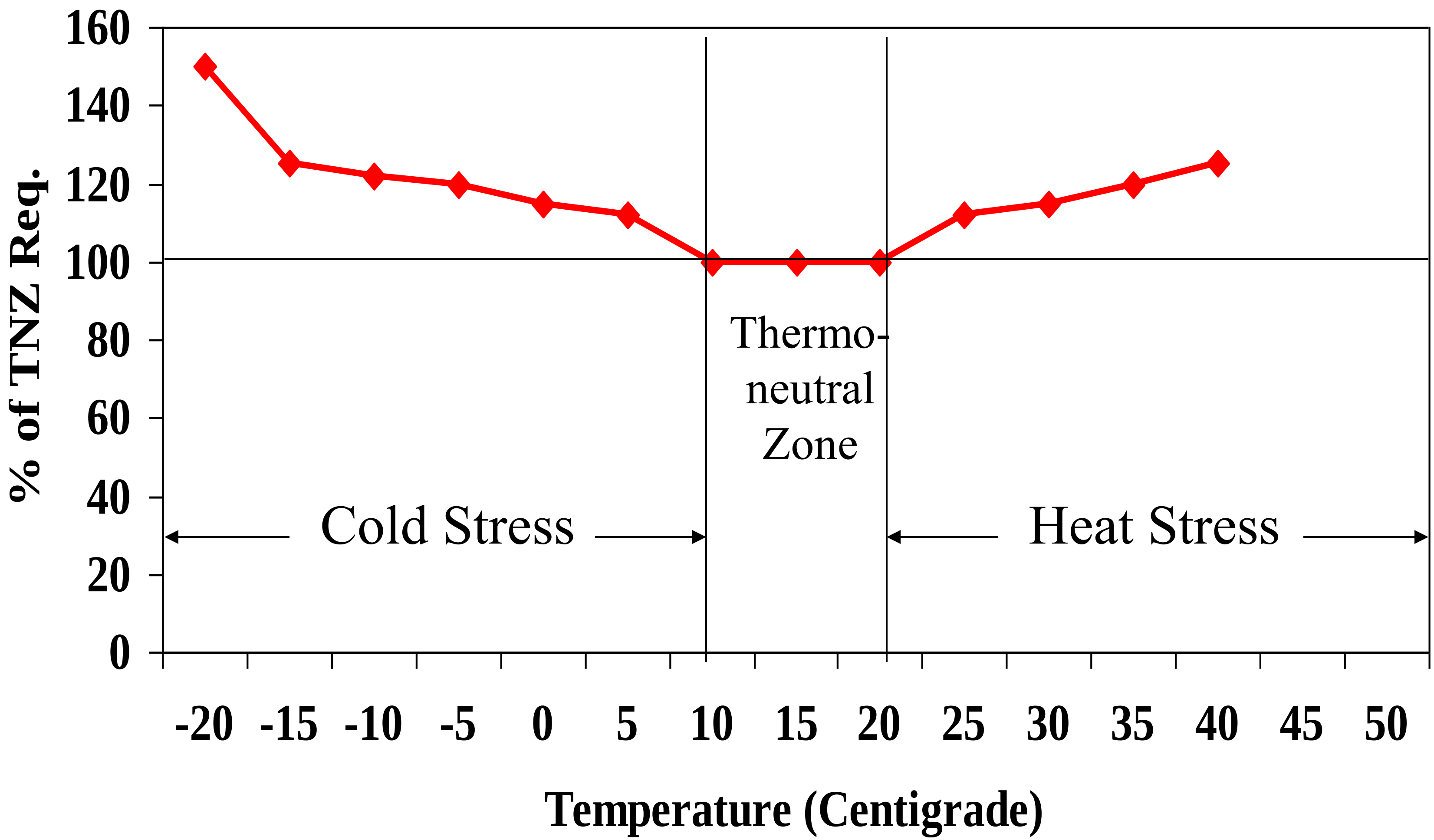
- Body fat content of calves at birth 3.8 to 4.5%
  - 40 kg calf – 1.6 to 1.8kg of fat

    (Roy, 1980; Diaz et al., 2001)

- Estimates of brown adipose tissue in neonatal ruminants range from 0.27 to 0.8 kg –
  - most used in the process of becoming a functioning mammal outside the placenta (Rowan, 1992)

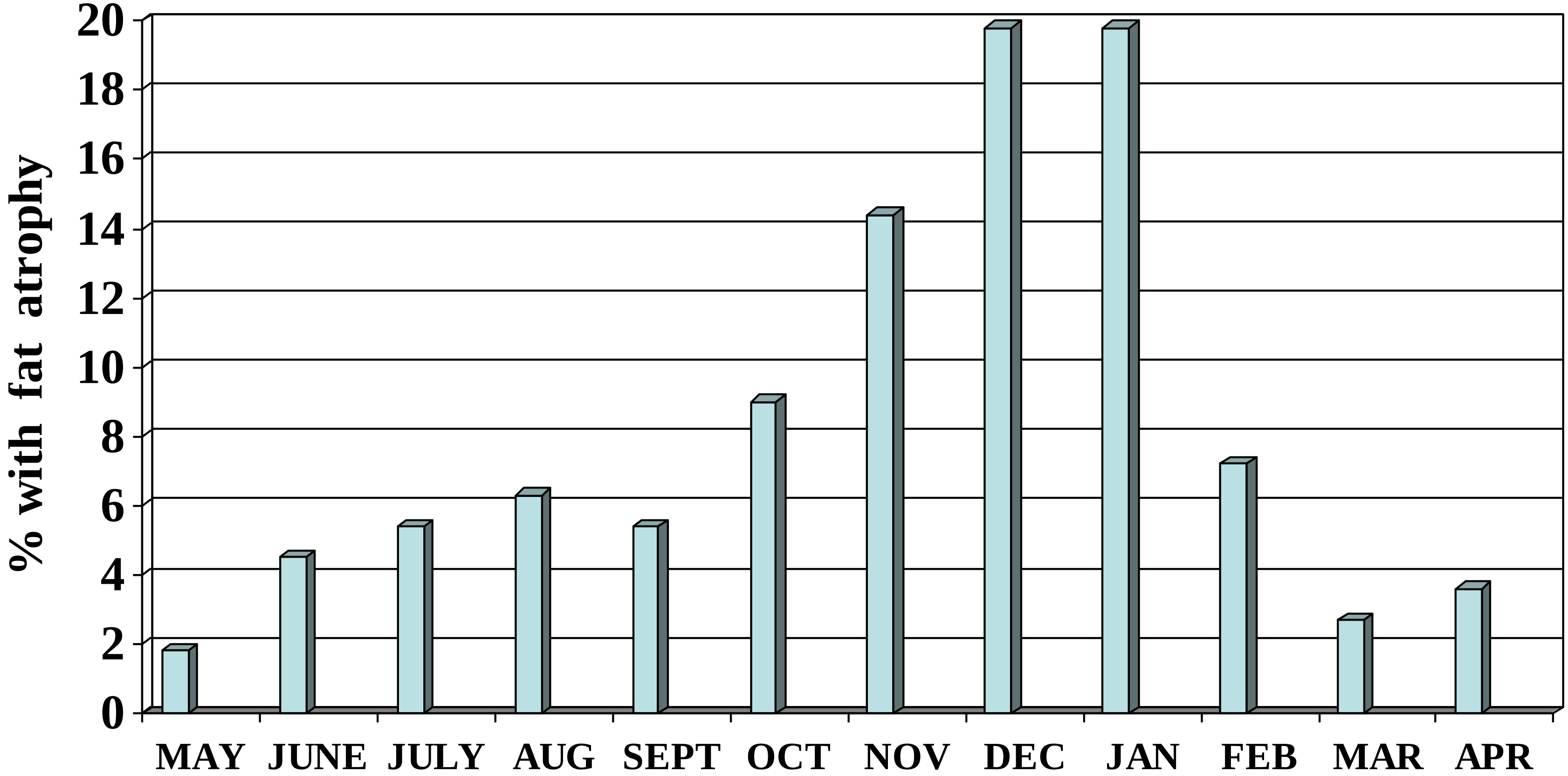
- Take home message: Energy reserves must quickly be replenished from the diet

Effect of ambient temperature on calf energy maintenance requirements



CAHFSL Data on Neonatal Calves
3 years submissions for diarrhea or death

111/845 = 13% had Atrophy of Fat



(From J. Reynolds; UC Davis)

Amount of 20:20 Milk Replacer/Milk Dry Matter (kg) Required for a 45 kg Calf to Meet Maintenance Requirements and Gain 0.45 kg per Day

Ambient Temperature (°C)						
20	**10**	**0**	**-9**	**-15**	**-20**	**-29**
0.64	**0.73**	**0.82**	**0.91**	**1.0**	**1.04**	**1.1**

Effect of Nutrient Intake on Health…

- Calves fed a higher plane of nutrition have:
  - Increased weight gain
  - Improved immune function: Can resist infection and/or recover more quickly from infection
  - Lower sickness and death loss
  - Greater ability to deal with cold stress

Williams et al., Anim. Prod. 1981. 32:133; Griebel et al. 1987. Can J. Vet. Res. 51:428
Pollock et al. 1993. Res. Vet. Sci. 55:298; Pollock et al., 1994. Br. J. Nutr. 71:239

Effects of Disease on Energy Requirements

- Sick Animals have increased energy expenditure:
  - Estimate for Calves: a 2 – 3.5 °F fever would increase maintenance requirements by 20-25% (45 kg calf = 0.4 to 0.5 Mcal ME or 0.1 kg DM) (Van Amburgh, SDI, 2007)
- Sick calves have reduced energy intake
  - Inflammatory cytokines, leptin cause decreased feed intake (Johnson, 1998)
- So,…where will the energy come from?
  - Diet (volume, nutrient density)
  - Body tissue reserves

Kidneys of two calves…

20:20 Milk Replacer

Whole milk or accelerated milk replacer program

Which of these two calves is in a better position to:
-Prevent an illness?
-Recover from an illness?
-Thrive and grow during cold weather?

From Bob James and Scott Bascom

Calf Nutrition from birth to weaning - Outline

- Rumen development
- Protein and Energy requirements:
  - Growth
  - Health
- **Liquid feeding programs**
- Starter management
- Water management
- Weaning strategies

Liquid Feeding Program Options

- **Liquid feed options**
  - Milk replacer (MR)
  - Saleable whole milk or waste milk (pasteurized)

- **Milk feeding costs if feed for 39 days (wean @ 42 days):**

	$/lb	lb fed/d	total $
20:20 MR	$1.40	1 lb powder	$54.60
Saleable milk	$0.16	8.8 (1 gal)	$54.91
Waste milk	$0.03	8.8 (1 gal)	$10.30 *

(* add pasteurizer costs)

- **Other Considerations:**
  - Desired nutrient intake: growth and health targets
  - Disease control
  - Complexity of managing feeding program
  - Cost-benefit

Milk or Milk Replacer Feeding Programs

Conventional vs Full potential

(or biologically normal growth)

Land O' Lakes Animal Milk Products

Conventional Calf Milk Feeding Programs

Thin calves

Photo from Bob James

- 10% of BWt in milk:
  - 0.5 kg (1 lb) powder/day or 4 L (1 gall) milk/day
  - 20% protein: 20% fat milk replacer
- WHY?
  - Cheap
  - Wean them early
- Is this the right approach?

How do we double birth weight by 8 weeks?

- Full potential milk program (20+% BWt):
  - Accelerated milk replacer (28:20) at 2-2.5 lb DM/day (0.5 kg DM/day)

    or

  - Whole milk (26:29) at 2-2.5 gallons/day (8-10 L/day)

= biologically normal growth before puberty

Impact of milk diet and intake on growth

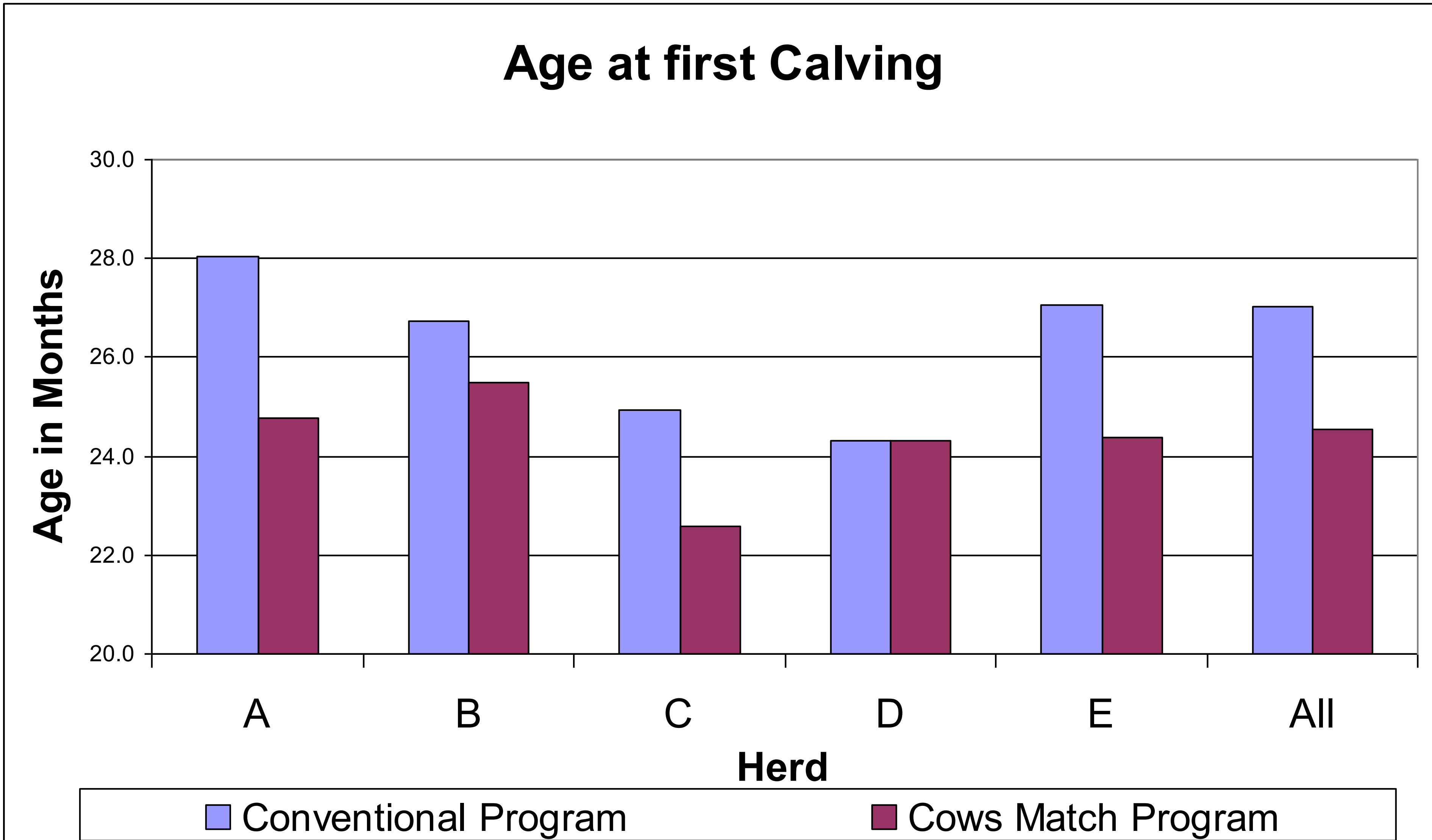
Calf fed 4 L/day 20:20 milk replacer (ADG = 0.23 kg/d)	Calf fed 8 L/day 28:20 milk replacer or milk (26:31) (ADG = 0.85 kg/d)

Impact of Plane of Nutrition on Future Performance

- Reduced age at first calving
- Improved milk production

Field Data from Land O'Lakes

23 herds summarized – five with lactation data



Meta-analysis of impact of preweaning ADG on first lactation milk yield

(10 studies. Soberon and Van Amburgh. *J ANIM SCI* 2013, 91:706-712)

Study Name	Difference in means (kg)	P- value
Bar-Peled et al., (1997)	453	0.072
Foldager et al., (1997)	265	0.043
Ballard et al., (2005)	703	0.028
Shamay et al., (2005)	546	0.042
Drackley et al., (2007) block 12	1,332	0.004
Drackley et al., (2007) block 22	342	0.040
Raeth-Knight et al., (2009)	718	0.168
Terre et al., (2009)	624	0.205
Morrison et al., (2009)	-91	0.498
Moallem et al., (2010)	732	0.042
Soberon et al., (2012) *	552	0.010
Meta-analysis of effect	**429**	**0.0001**

* Observational study representing ADG of 0.35 and 0.7 kg/day and respective yield differences

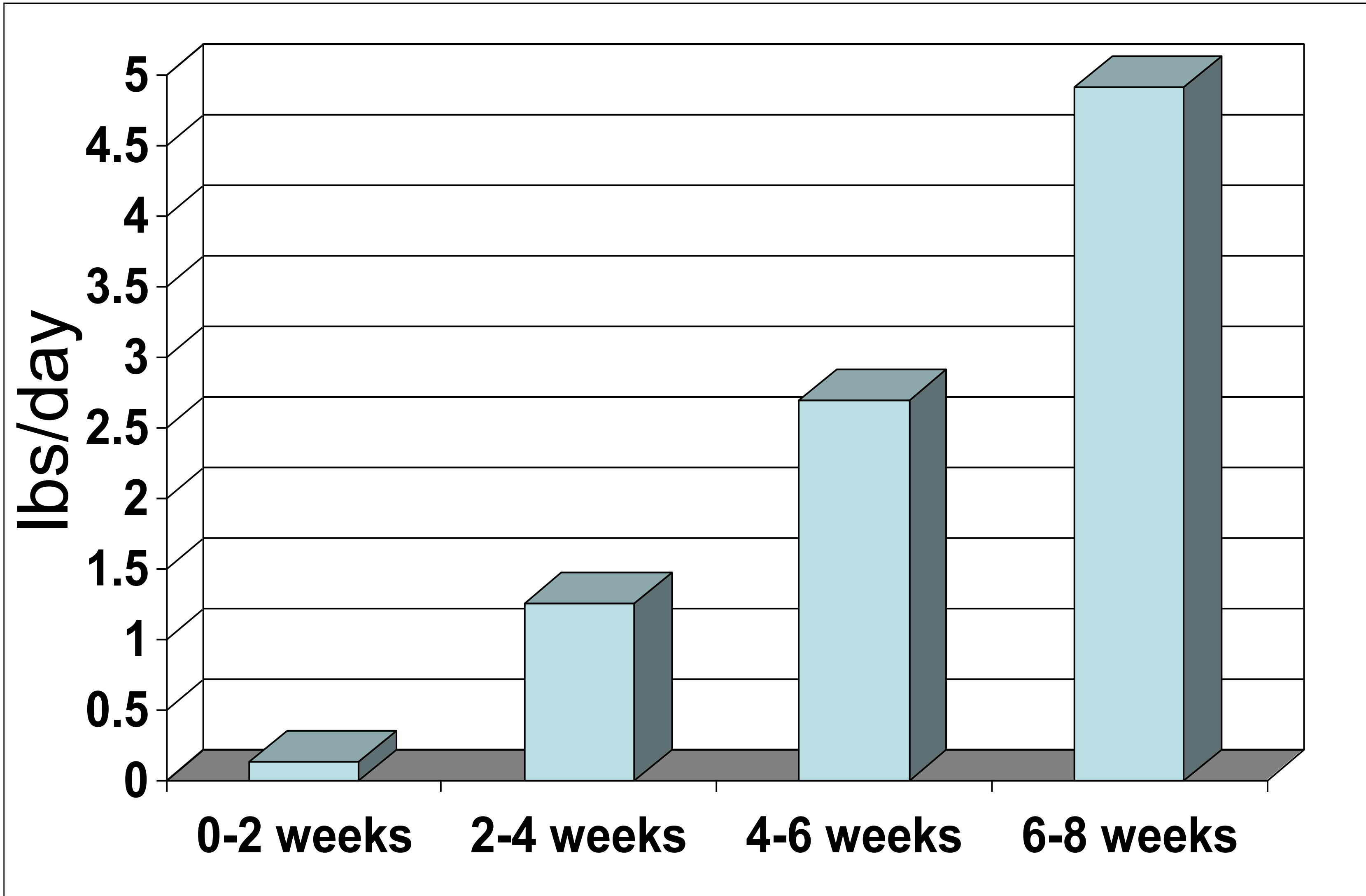
Calf Nutrition from birth to weaning - Outline

- Rumen development
- Protein and Energy requirements:
  - Growth
  - Health
- Liquid feeding programs
- **Starter management**
- Water management
- Weaning strategies

Starter Management

- Want to encourage starter intake to promote rumen development => allow weaning (cheaper diet)
- Calves prefer:
  - textured starters (pellets with corn/oats + molasses)
  - Avoid fines, dust,
  - Fresh (no mold), palatable, free choice
- For best results:
  - 21-23% CP on DM basis
  - Molasses content 5-8%
  - Begin offering at 3 days and replace daily
  - Provide free choice fresh water
  - Put in clean buckets
  - Put in mouth after milk feeding

Calf Starter Intake



U of MN Southern Research and Outreach Center

Calf Nutrition from birth to weaning - Outline

- Rumen development
- Protein and Energy requirements:
  - Growth
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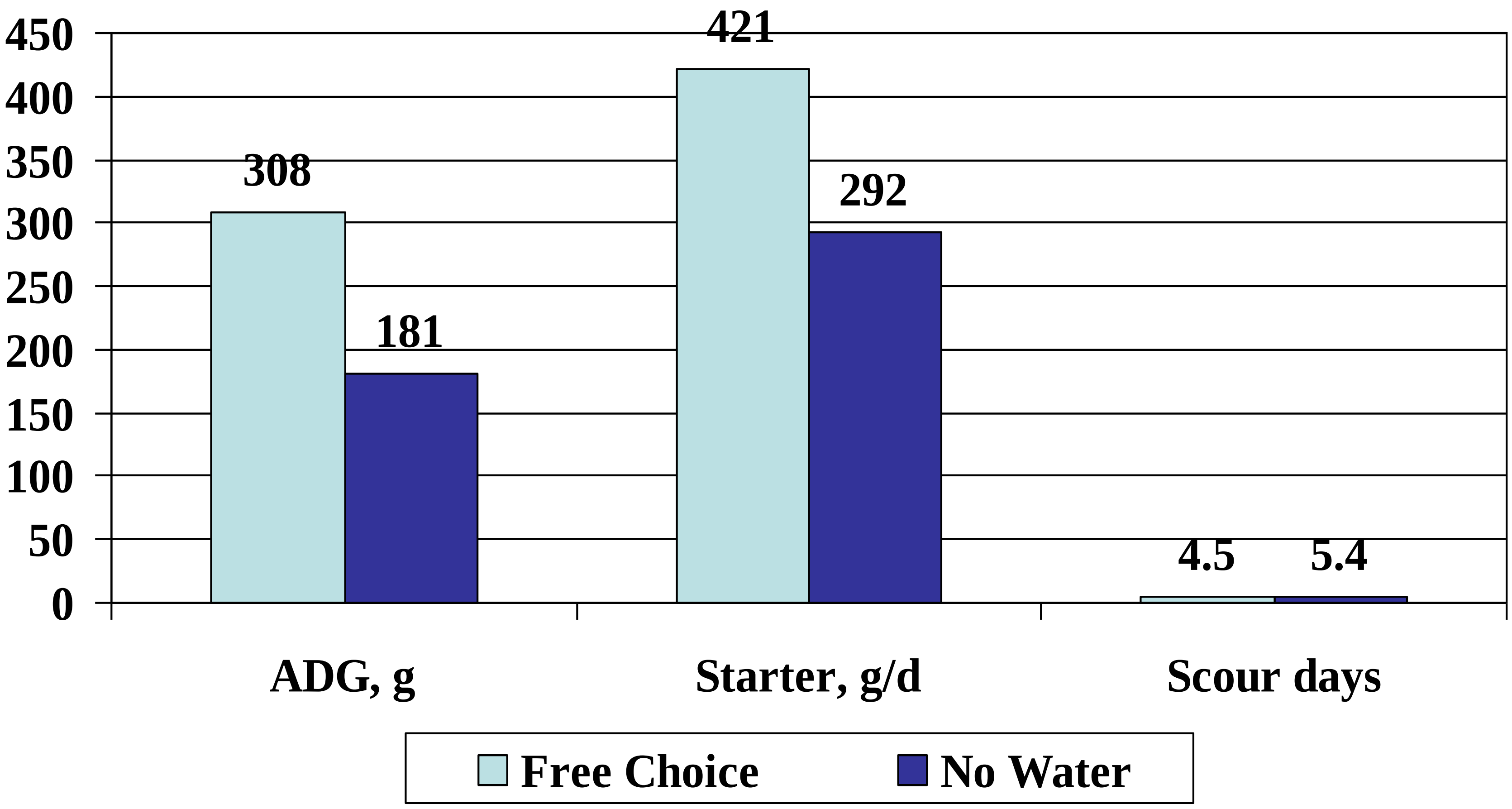
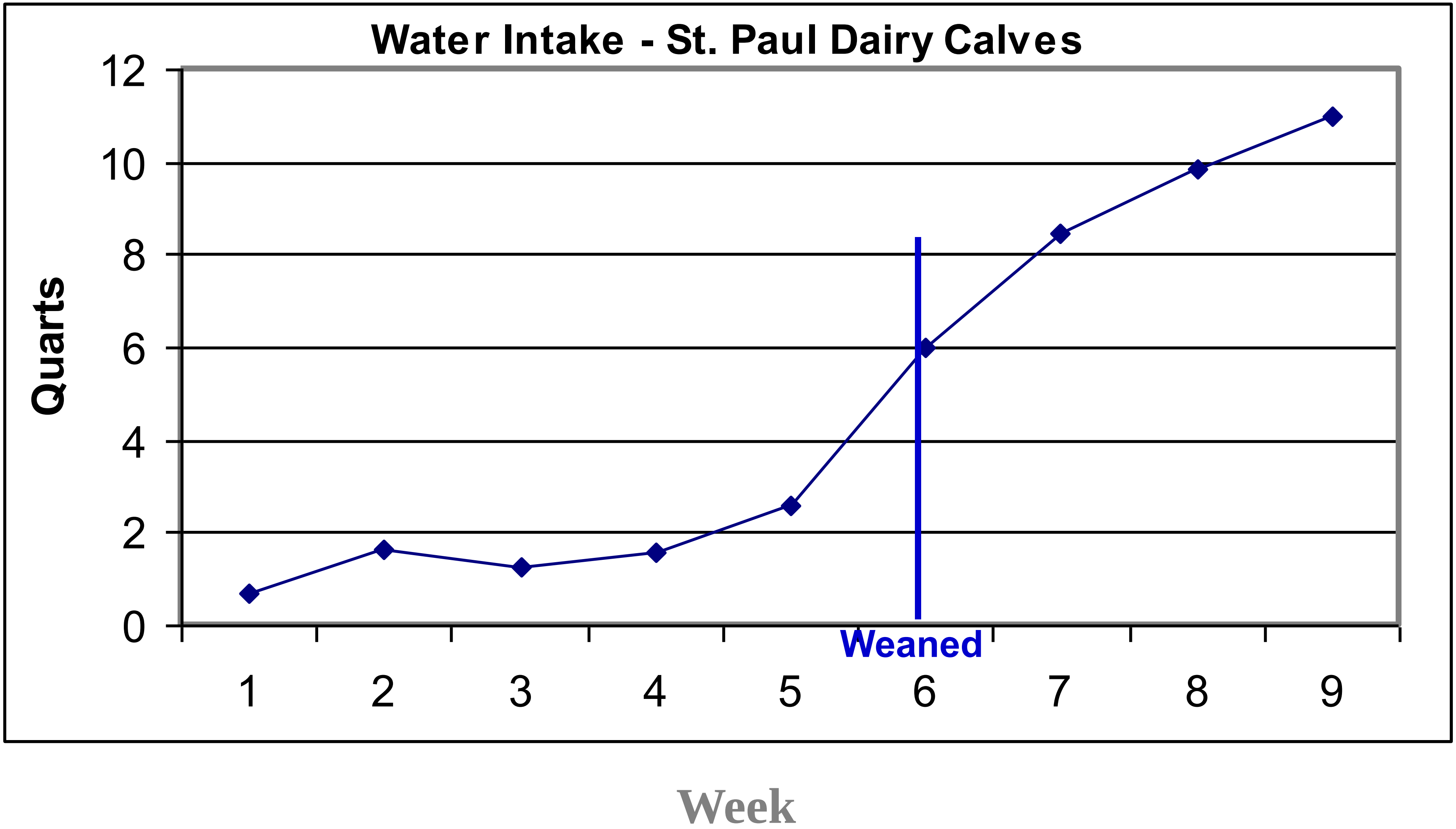
Importance of Free Choice Water

- Promotes rumen development by…
  - Providing an aqueous environment for bacteria (milk or milk replacer by-passes rumen via esophageal groove)
  - Promote intake of dry feed
- Essential to maintain hydration status, especially during periods of:
  - Heat stress
  - Illness (e.g. scours)

ANIMAL PERFORMANCE WHEN OFFERED WATER FREE CHOICE



Kurtz, J Dairy Science, 1984


Water Intake - St. Paul Dairy Calves
Quarts
12
10
8
6
4
2
0
Weaned
1
2
3
4
5
6
7
8
9
Week

Water Guidelines

- Provide free choice fresh water beginning at 3 days old and replace twice daily
- Clean/disinfect buckets regularly
- Summer: Check water mid-day, offer 3rd feeding if needed
- Free choice water essential if feeding 'accelerated' milk replacer program

Calf Nutrition from birth to weaning - Outline

- Rumen development
- Protein and Energy requirements:
  - Growth
  - Health
- Liquid feeding programs
- Starter management
- Water management
- **Weaning guidelines**

Weaning Guidelines

Photo courtesy of Sam Leadley

- Usually 8-9 weeks (older is better)
- Before weaning, calves should be:
  - Eating starter grain for at least 5 weeks
  - Consuming ≥ 1.5 kg starter grain per day for at least 3 consecutive days before begin weaning process
  - To increase starter intake, can reduce milk volume by 50% in last 10-14 days, or do slow taper of daily milk allowance, prior to weaning

Weaning Guidelines

- Avoid other stressful events during the weaning period:
  - Do not change grain until 2 weeks after weaning
  - Dehorning or vaccination should be done at least 2 weeks before weaning, or 2 weeks after weaning
  - Delay moving into a group pen until at least 1-2 weeks after weaning
  - Avoid transportation
  - Avoid significant environmental changes

Weaning Guidelines

- Moving to group pens after weaning:
  - Keep in individual pen for 7-14 days after weaning
  - Move to small groups initially (6-8 calves)
  - Continue on same grain for 1-2 weeks after grouping
  - Introduce forages after 3-4 weeks post-weaning

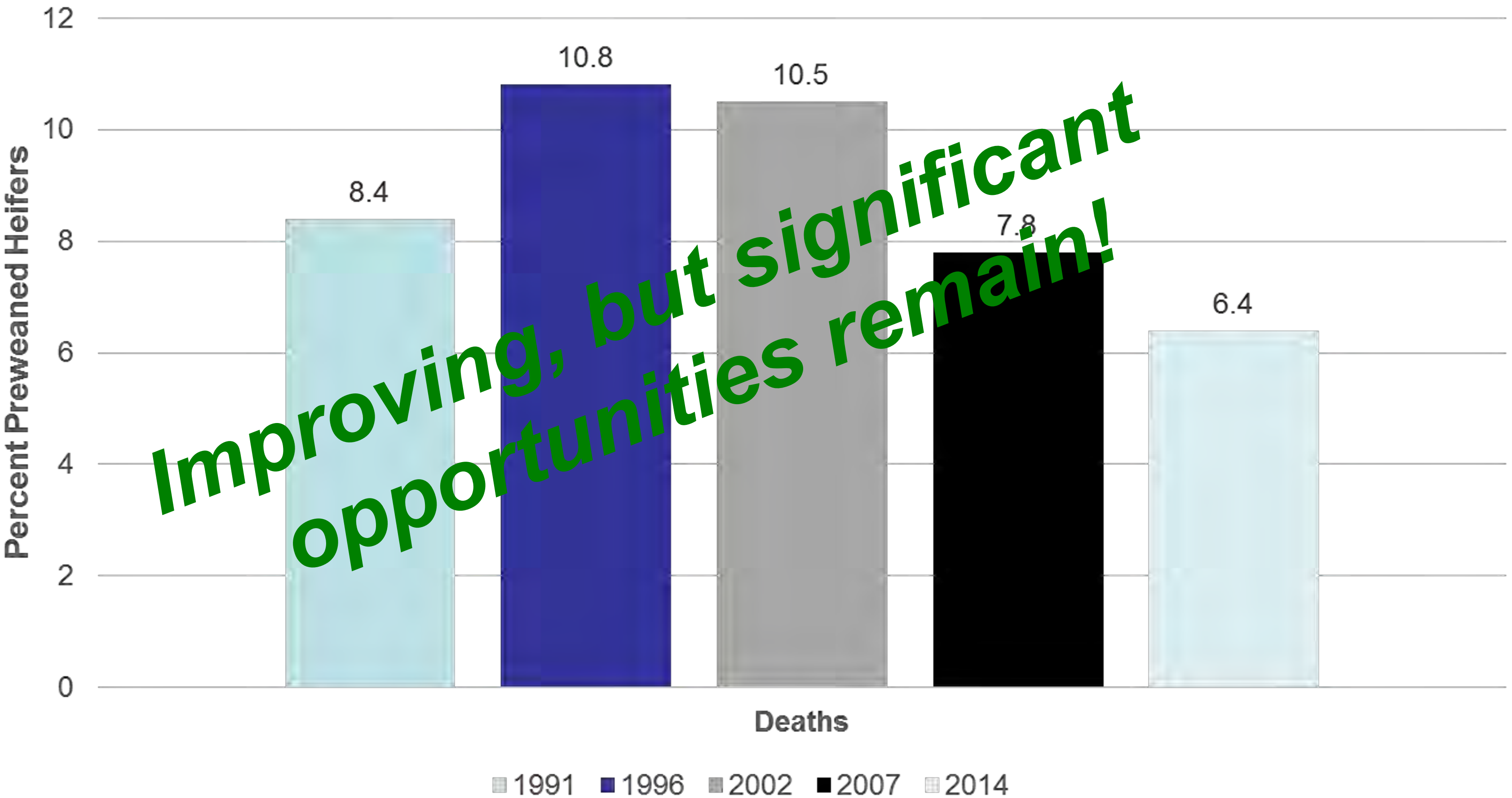
Nutrition Summary

- Early life nutrient intake has:
  - Short term impacts on health, growth
  - Long term impacts on productivity (and therefore economics)
- FEED THEM!!!

What's New in Colostrum Management?

Sandra Godden DVM, DVSc
Department of Veterinary Population Medicine
University of Minnesota

Is the Dairy Industry Succeeding with Calf Health Management?

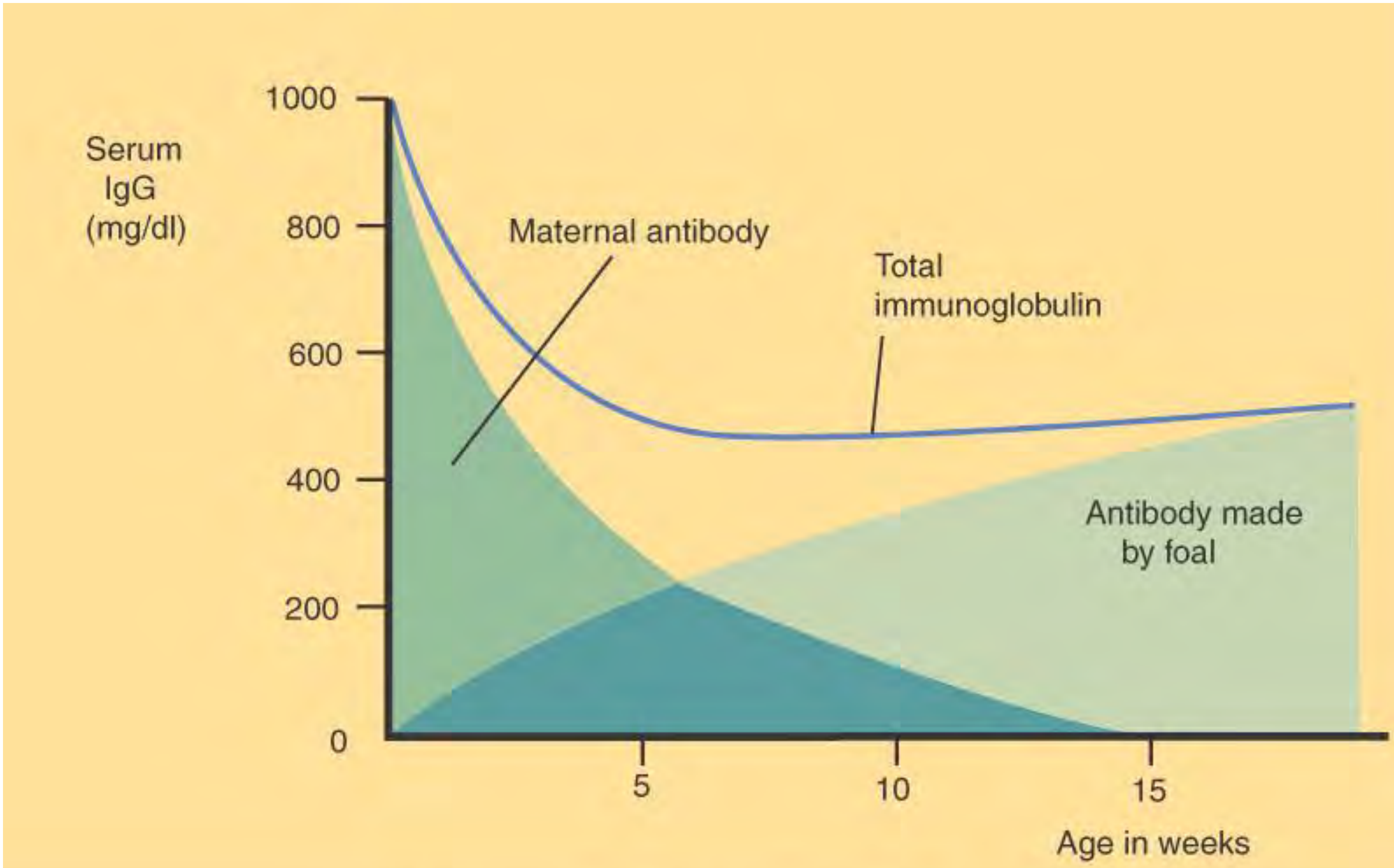


NAHMS Dairy 2014

Key Management Areas for Preweaned Calves

- Late gestation
- Maternity pen management
- Care of newborn calf
- **Colostrum management**
- Housing and sanitation
- Preweaning nutrition
- Disease detection and treatment
- Pain management

The role of colostrum in calf health



- Colostral (maternal) antibody protects neonate for first weeks/months until neonate's acquired immune system produces protective antibodies

Colostrum is a source of…

- **Immunoglobulins**:
  - IgG = 85-90% (IgG_1 = 80-90%, IgG_2 = 10-20%)
  - IgA = 5%
  - IgM = 7%
- **Leukocytes** (>10^6 /ml): macrophages, neutrophils, lymphocytes
  - Calves fed cell free colostrum => vaccinated btw 5-10 mos => had ↓ gene expression of IL-2 and ↓ T cells in month 0 and 1 after vaccination => Maternal WBCs have long-term effect on development of immune system
- **Other factors that stimulate neonatal immune system**:
  - Cytokines: γ-interferon, interleukin-6
  - Growth factors (IGF-1, IGF-2), hormones (insulin, cortisol, thyroxine)
  - Vitamins and minerals
  - Tripsin inhibitor: prevents proteolytic degradation of Ig
- **Nonspecific antimicrobial agents**: lactoferrin, lysozyme
- **Fluid source** – Increase blood volume

(Reiter, 1977; Riedel-Caspari, 1993; Archambault, 1988; Le Jan, 1996; Xu, 1996; Reber et al., 2005; Langel et al., JDSci 2016. 99:3979)

Nutritional/Endocrine Significance

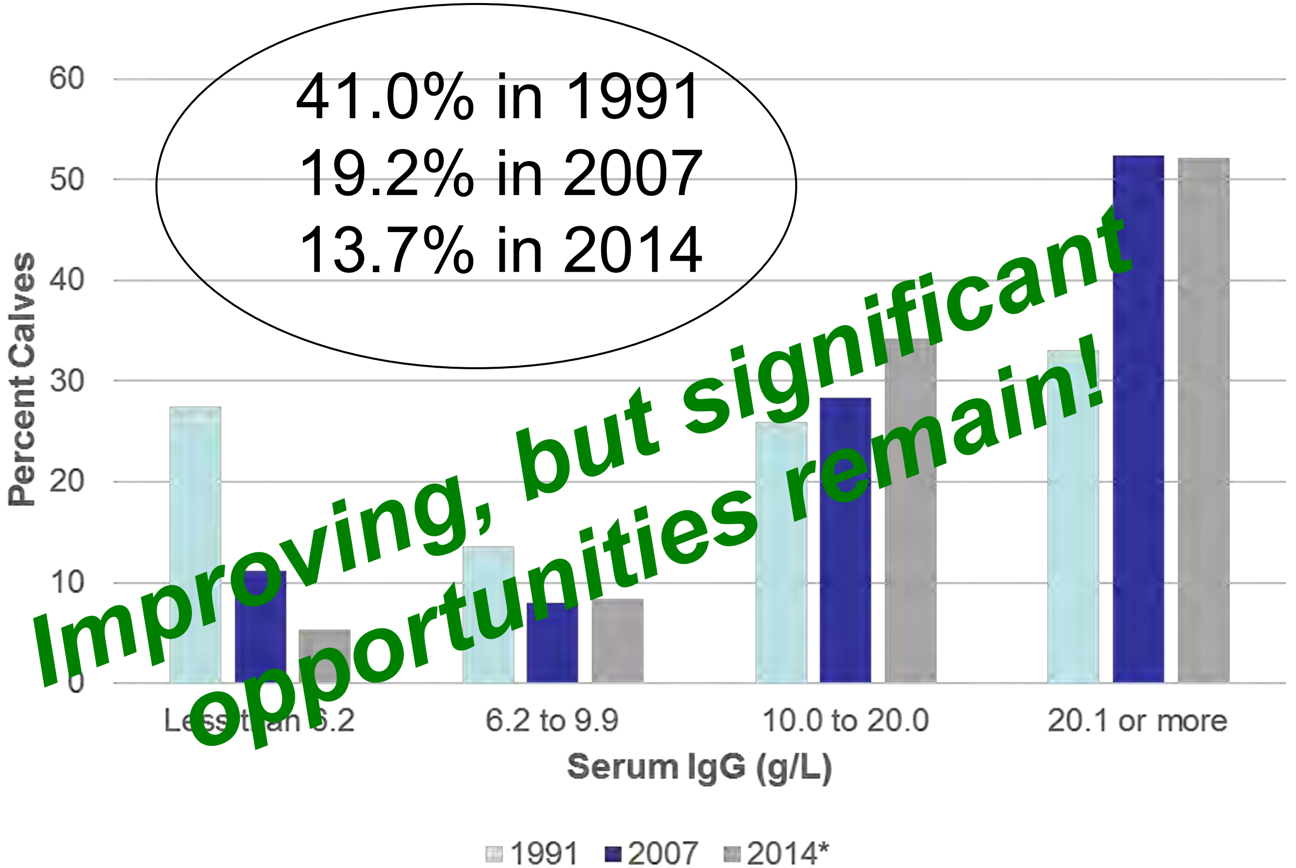
Factor	Colostrum (milking postpartum) 1	2	3	Milk
Total solids (%)	23.9	17.9	14.1	12.5
Fat (%)	6.7	5.4	3.9	3.6
Lactose (%)	2.7	3.9	4.4	4.9
Total protein (%)	14.0	8.4	5.1	3.2
Casein (%)	4.8	4.3	3.8	2.5
IgG (g/100mL)	3.2	2.5	1.5	0.06
Vitamin A (µg/L)	2960	1900	1130	340

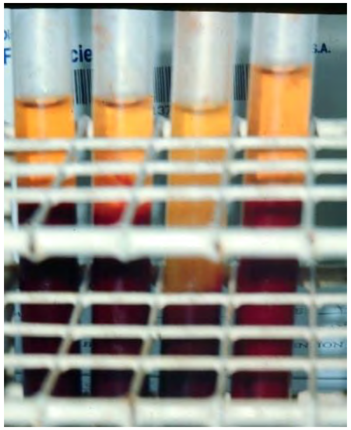
(Davis and Drackley, 1998)

- **Nutrients (esp. energy/heat):** thermogenesis, maintenance, growth
- **Epigenetic programming**: hormones & growth factors => gene expression
    - Calves born to heat-stressed dams had lower IgG absorption, poorer reproductive performance and reduced first lactation milk yield

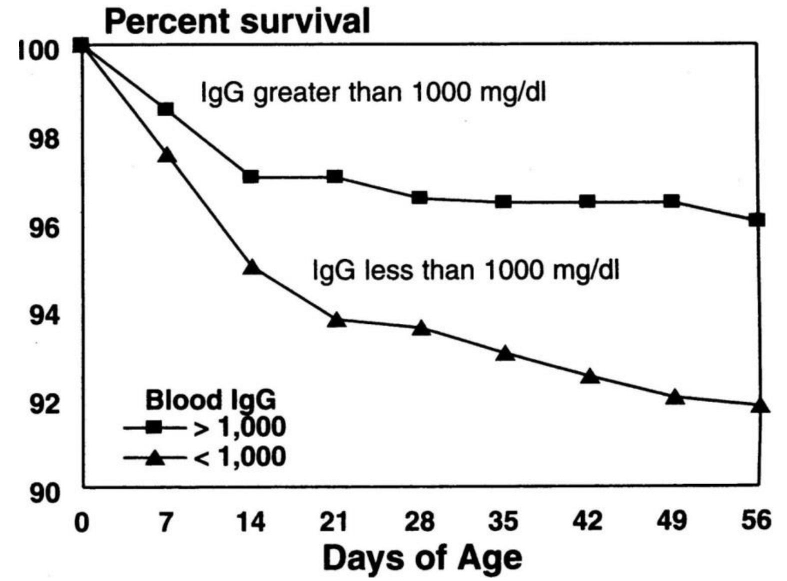
(Dahl et al., JDSci. 91:3193. 2016)

- Failure of passive transfer (FPT) (NAHMS):
  - Serum IgG > 10 g/L (sample 1-7 days old)





Benefits of Successful Passive Transfer



- Reduced treatment and mortality rates
  (NAHMS, Wells, 1996)
- Improved growth rates and feed efficiency
  (Fowler, 1999; Faber et al., 2005; Nocek et al., 1984; Robison et al. 1988; Faber. 2005)

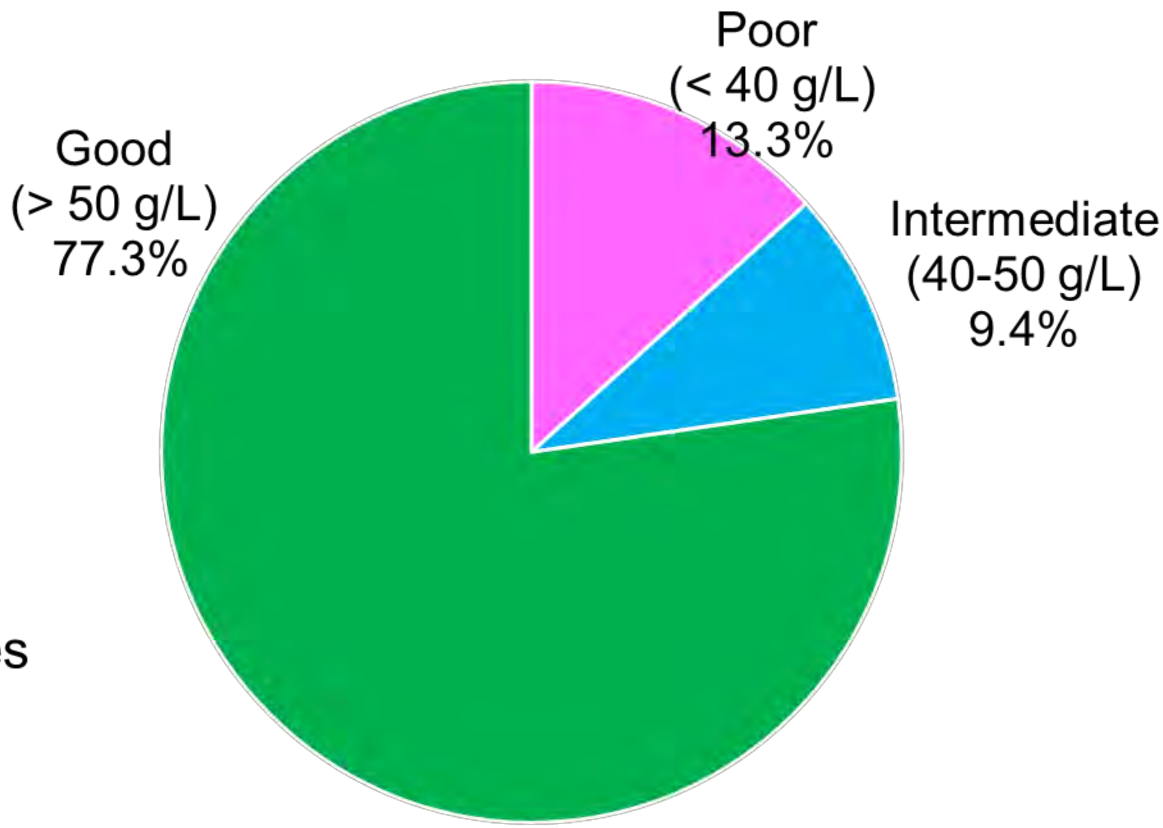
- Decreased age at first calving
  (Faber et al. 2005)
- Increase 1st & 2nd lactation milk production
  (DeNise, 1989; Faber, 2005)

The 5 Q's of Colostrum Management

- **Q**uality
- **Q**uantity
- **Q**uickness
- S**Q**ueeky clean (bacterial contamination)
- **Q**uantifying passive transfer (monitoring)

1. COLOSTRUM QUALITY

(Goal: IgG ≥ 50 g/L)



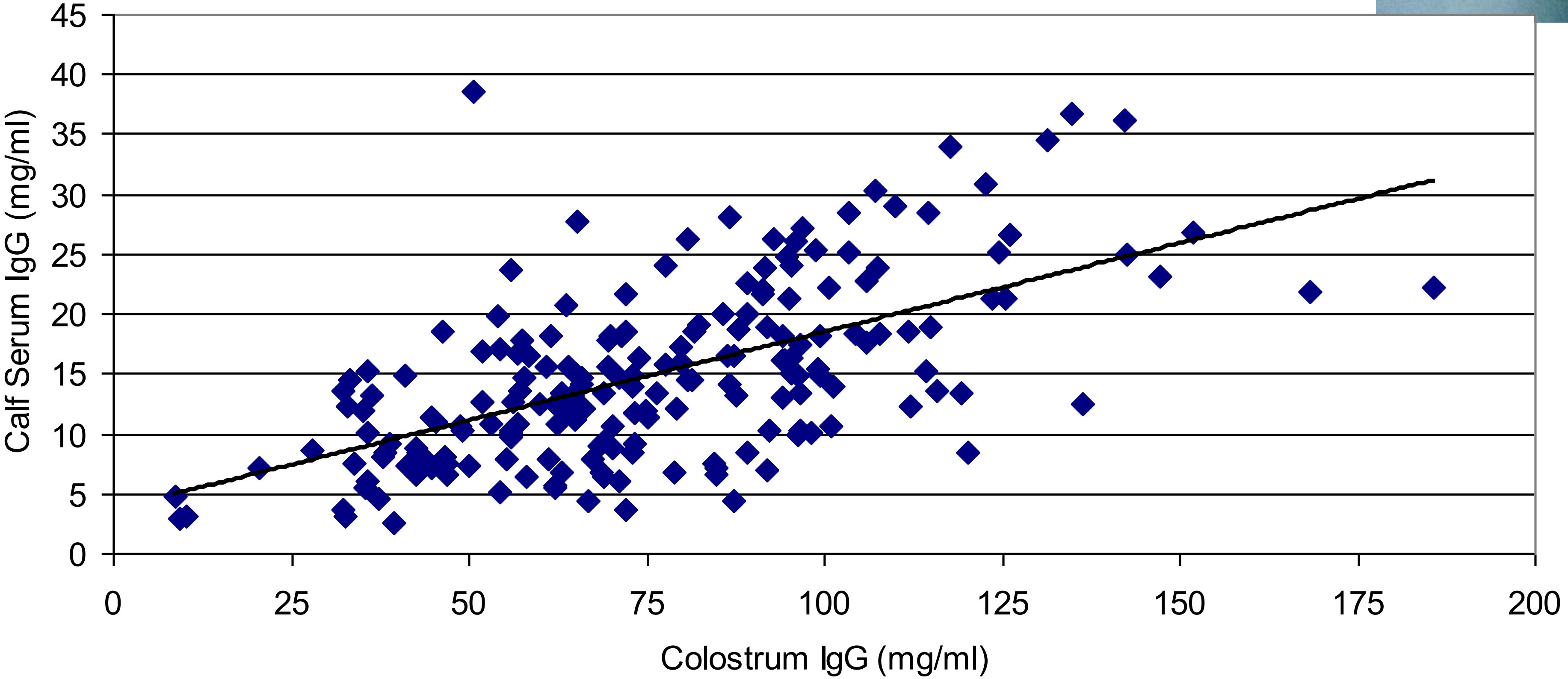
n=2,532
heifer calves

Mean colostrum IgG: 74.6 g/L (SE 0.64)

NAHMS Dairy 2014

1. COLOSTRUM QUALITY

(Goal: IgG ≥ 50 g/L)



- Positive relationship between IgG in colostrum vs calf serum
- Colostrum quality is highly variable

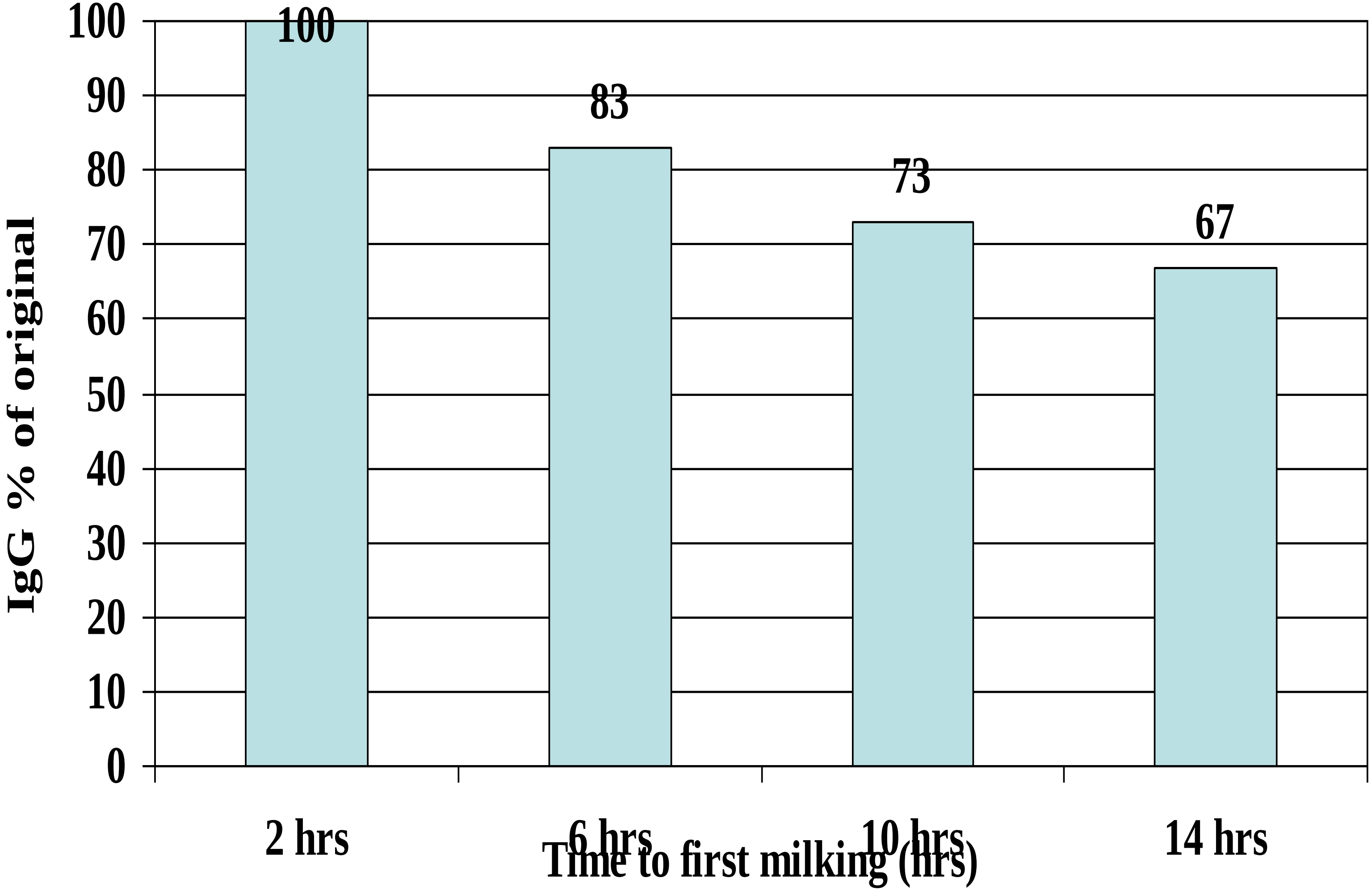
Factors affecting colostrum quality that ARE under management's control

- Dry Cow Nutrition
- Vaccination During Dry Period
- Stressors (e.g. heat stress)
- Excessively long (> 90d) or short dry periods:
  - < 21 days dry: Lower Ig concentration (Dixon et al., 1961)
  - 40 (vs 60) days dry: 2.2 kg less colostrum volume (Grusenmeyer et al. JDS 2006)
- Delay from calving to colostrum harvest

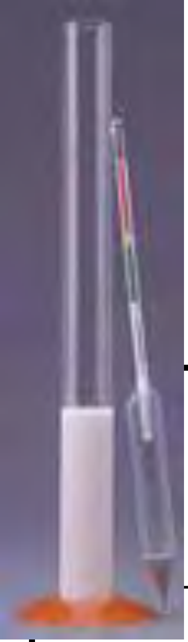
Effect of Delaying First Milking on Colostrum Quality

(Moore et al., J.A.V.M.A. 2005. 226:1375)

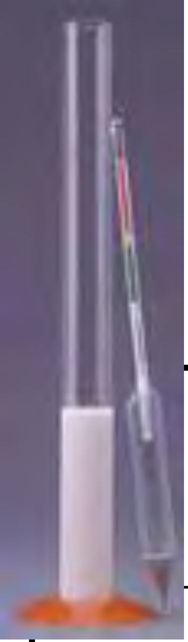
13 cows – 52 quarters



Cow-side Tests of Colostrum Quality: Colostrometer or Brix Refractometer



	Instrument Cutpoint Used	Sensitivity (%)	Specificity (%)	Cost	Pros / Cons
Colostrometer IgG < 50 g/L (Chigerwe, JAVMA 233: 2008)	Green	75% (recc: cutpoint 70)	87%	$40	Rapid, Simple / Fragile, Temperature dependent
Optical Brix Refractometer IgG > 50 g/L (Bielmann JDSci. 2010)	≥ 22%	90.5%	85%	± $80	Rapid, Simple, Not temp. dependent



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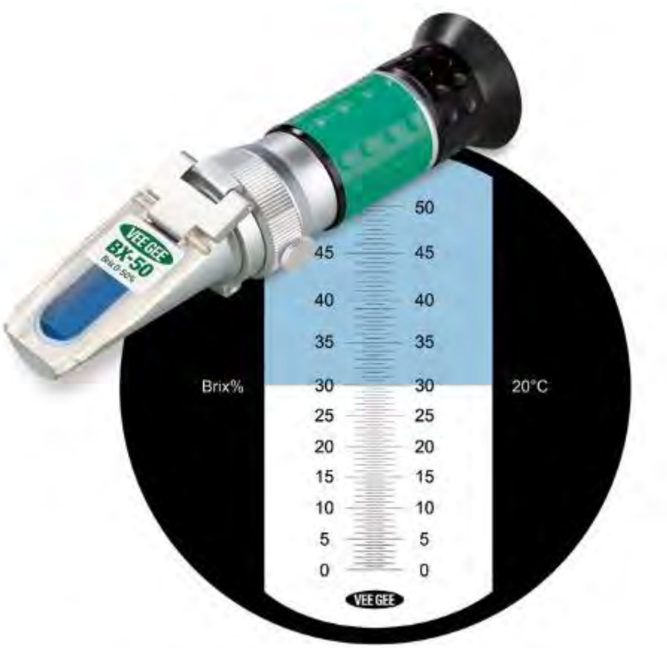
Optical Brix Refractometer IgG > 50 g/L (Bielmann JDSci. 2010)	≥ 22%	90.5%	85%	± $80	Rapid, Simple, Not temp. dependent

Brix Refractometer Examples
(> 22% on Brix scale = Good colostrum)

MISCO Palm Abbe Digital Refractometer
- www.MISCO.com. Cleveland, OH
- Cost: $300+
- Scales:
    - Brix scale (%) for colostrum or serum
    - Serum total protein scale (g/dl)
    - Whole milk total solids estimate (%)



Vee Gee BX-50 Optical Brix Refractometer
- http://www.amazon.com
- Cost: $100
- Scales:
    - Brix scale (%) for colostrum or serum or to estimate milk total solids

The 5 Q's of Colostrum Management

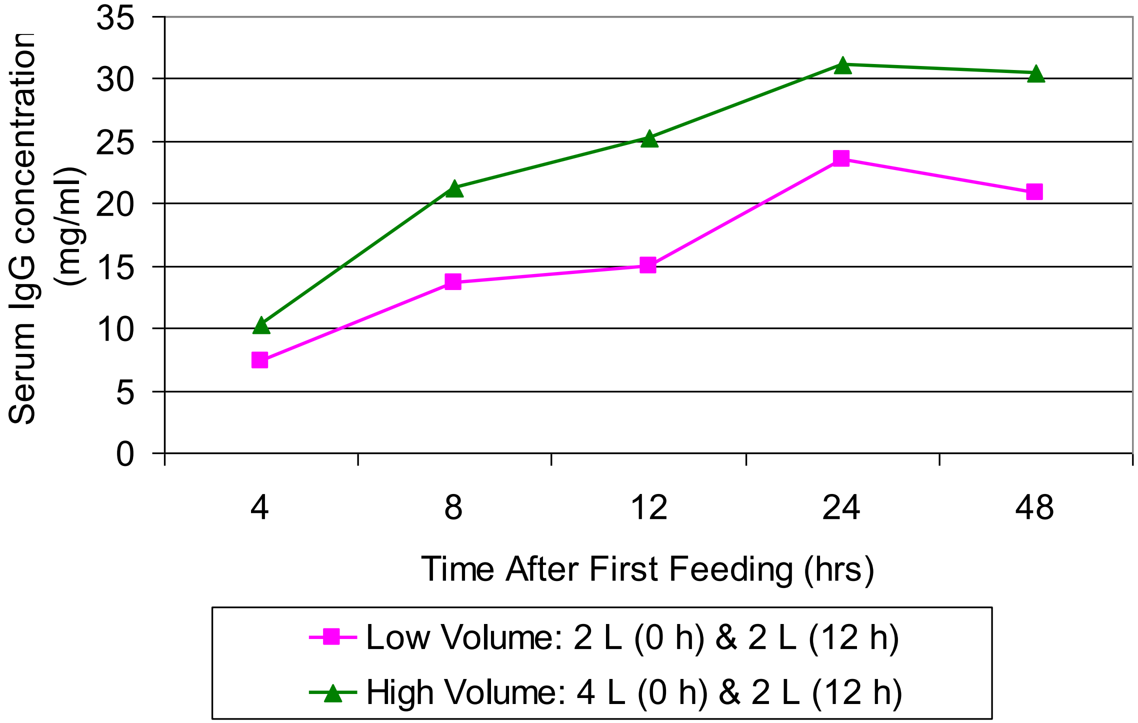
- **Q**uality: > 50 g/L IgG
- **Q**uantity
- **Q**uickness
- S**Q**ueeky clean (bacterial contamination)
- **Q**uantifying passive transfer (monitoring)

2. COLOSTRUM QUANTITY

What volume should we provide at first feeding?

Colostrum Quantity – Dairy calves

- Goal: Feed 150 - 200 g of IgG fed within 2 hours of birth (Maximum of 4-6 hours)
- Recommended: 10% BWt: Large breeds: Feed 3.5 to 4 L
  Small breeds: Feed 2.5 to 3 L



Effect of colostrum volume on calf serum IgG concentrations

Morin et al., 1997

The 5 Q's of Colostrum Management

- **Q**uality: > 50 g/L IgG
- **Q**uantity: 10% of Birth Weight
- **Q**uickness:
- S**Q**ueeky clean (bacterial contamination)
- **Q**uantifying passive transfer (monitoring)

3. QUICKNESS (time to first feeding)

Ig in intestinal epithelial cell

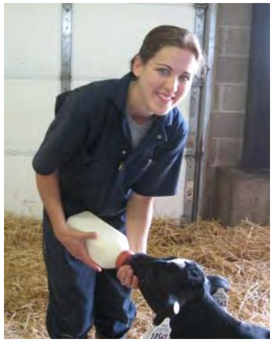
- Why the concern?
  - Progressive closure of gut begins soon after birth (replacement of epithelial cells lining GIT) => Progressive loss of ability to absorb IgG
  - Complete closure by 24 hrs

- Goal: Feed within 1-2 hrs (4-6 hrs max)

Options for ‘Quick Colostrum Feeding’

- It’s 11:00 PM and the calf was just born
  Goal: Feed within 1-2 hrs (6 hrs max)

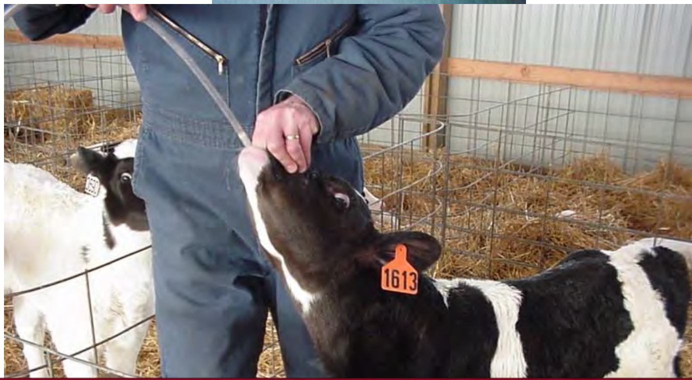
- Options:
  - Milk cow and feed calf within 1-2 hrs
  - Feed calf refrigerated stored colostrum
  - Feed calf frozen stored colostrum
    - Don’t heat > 140 ºF when thawing
    - Keep water bath dish water hot (120-125 ºF)
  - Feed a colostrum replacer product



Does Colostrum Feeding Method Matter?

- Options:
  - Suckling the dam
  - Bottle
  - Tube

- This could affect:
  - Quantity
  - Quality
  - Quickness
  - Cleanliness



Suckling Mom is NOT Recommended

- High rate of FPT with suckling
  - due to delays in suckling.
    (Edwards & Broom. 1979. Res. Vet. Sci. 26:255-256)

Lactation num. of dam	% calves not suckled within 6 hr
1	11%
2 +	46%

  - Don't know volume consumed.
  - Increased risk of pathogen exposure

- Preferred: Bottle or Tube (your choice)

Bottle vs Tube?

(Chigerwe et al. JAVMA. 2012. 241:104)

- Design: 26 newborn calves paired up: 1 bottle/1 tube
  - Bottle calf: Fed as much as would consume in 20 min
  - Tube calf: Fed same volume via tube
  - Measured serum IgG at 48 hrs
- Results:

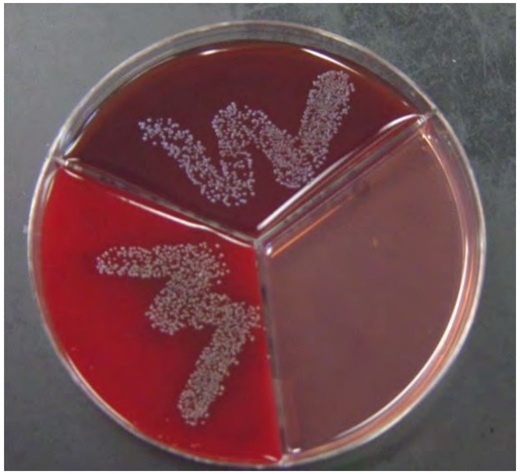
	Bottle	Tube	P value
Volume Consumed (L)	2.2 L (1 to 4)	2.2 L (1 to 4)	-
Serum IgG at 48 hr (mg/ml)	6.6	7.3	0.51
% with FPT (IgG < 10 mg/ml)	85% (11 of 13)	85% (11 of 13)	1.0

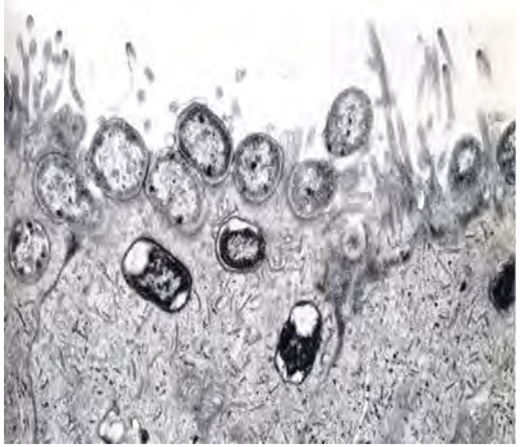
- Conclusion: No effect of feeding method (volume signif.)

The 5 Q's of Colostrum Management

- **Q**uality: > 50 g/L IgG
- **Q**uantity: 10% of Birth Weight
- **Q**uickness: ASAP (1-6 hrs)
- S**Q**ueeky clean (bacterial contamination)
- **Q**uantifying passive transfer (monitoring)

4. S**Q**ueeky Clean (Bacterial Contamination)

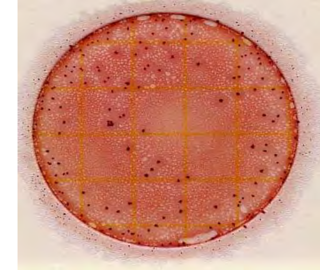




Cleanliness Outline

- Levels of contamination:
  - Goals vs reality
- Consequences of contamination
- Sources of contamination
- Control points for reducing contamination

How often do producers feed contaminated colostrum?



- Goal:
  - TPC < 100,000 cfu/ml
  - TCC <   10,000 cfu/ml

Sheila McGuirk
UWI-Madison

Sam Leadley
Attica Vet, NY

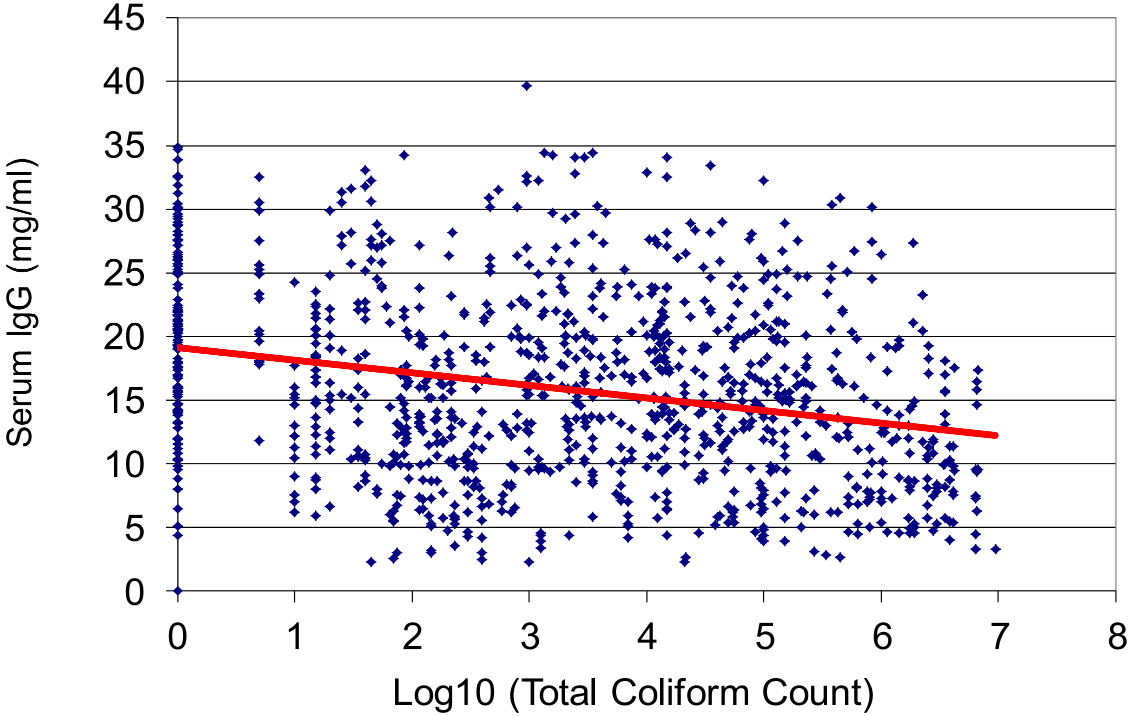
- National study: 43% of 827samples from 67 herds exceeded limit
  (Morrill et al., 2012. JDSci 95:3997)

Consequences of microbial contamination of colostrum?

- Pathogens may cause disease
  (e.g. *E. coli*, *Salmonella* spp., *Mycoplasma* spp., *M. avium* subsp. *paratuberculosis*)

- Bacteria counts are associated with ↓ serum IgG levels

  James et al., JDSci 1981;
  Poulson et al., ACVIM 2002;
  Godden et al., JDSci 2012



Sources of Microbial Contamination


1. Cow: Infected gland or fecal contamination



2. Contaminated collection, storage or feeding equipment


3. Bacterial proliferation in stored colostrum

Critical Control Points to Reduce Contamination


- Cow
  - Identify infected cows (MAP)
  - Don't let calf suckle dam
  - Udder prep
  - Don't pool raw colostrum



- Equipment
  - Sanitation of milking, storage & feeding equipment


- Proliferation
  - Feed ASAP (< 1-2 hrs)
  - Refrigerate (< 48 hrs)
  - Freeze
  - Preservatives
- Replacers, Heat-treating

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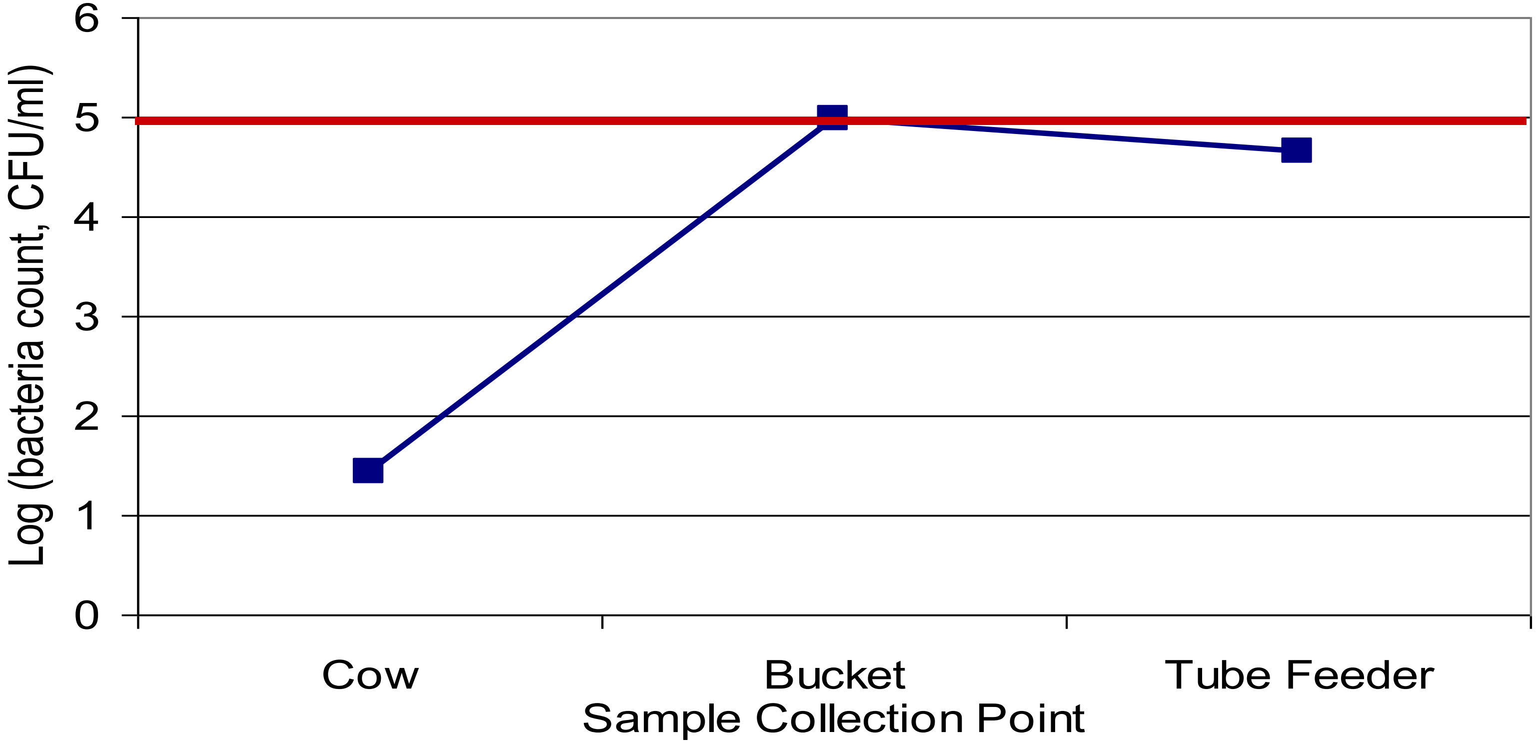
Sources of Contamination:

Contamination During Colostrum Harvest

(Stewart et al. JDS. 2005. 88)



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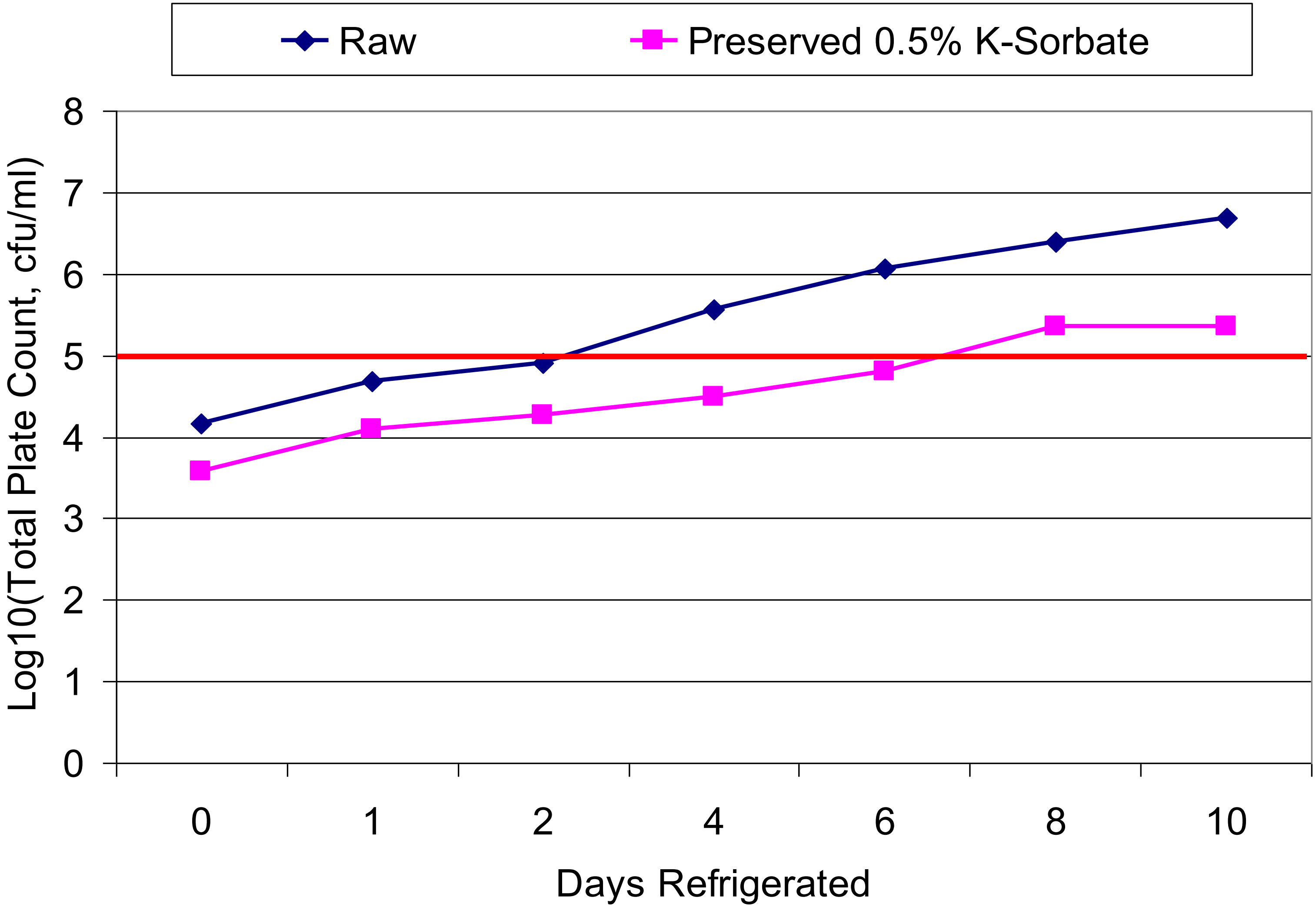
Sources of Contamination:

Bacterial Proliferation in Stored Colostrum

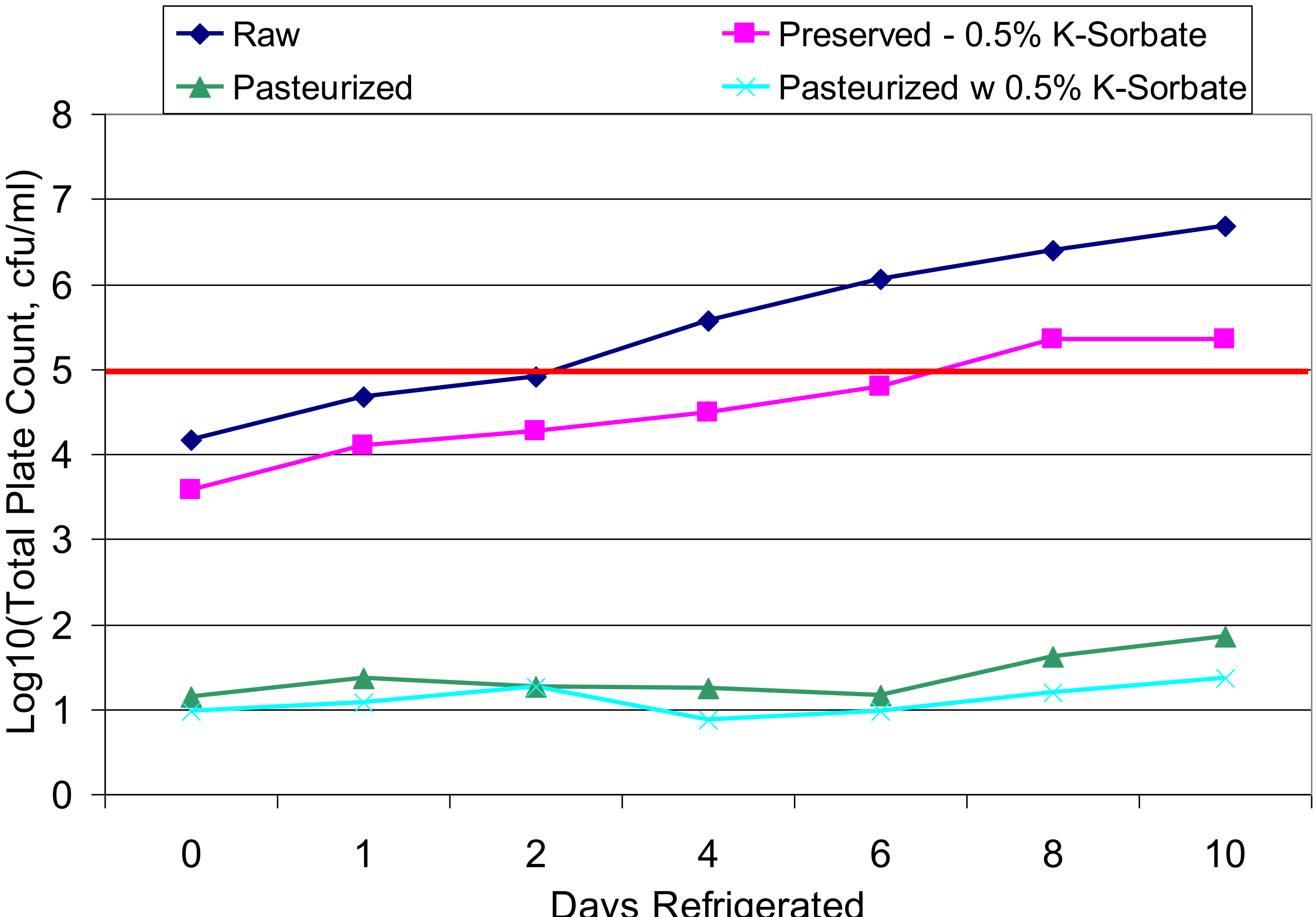
(U of MN, Summer, 2006)



Sources of Contamination:

Bacterial Proliferation in Stored Colostrum

(U of MN, Summer, 2006)



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Colostrum Supplements and Replacers
Outline

- Definitions & places for use on dairies
- Manufacture & licensing
- Evaluating efficacy:
  - Dose of IgG
  - Efficiency of absorption of IgG
  - Passive transfer (serum IgG) in calves
  - Calf health, performance
  - Infectious disease control

Colostrum Supplements

- $9 to $18 USD per dose
- Lacteal or serum-derived IgG
- 25 to 60 g IgG per dose
  - Inadequate IgG and nutrients if fed alone
- Intended to supplement poor quality or inadequate volume of maternal colostrum:
  - No value to supplementing high quality MC
  - Useful to supplement low quality MC
- Recommend reconstitute with water as per label (don't dump powder directly into MC)?
  - MN/WI study reported no negative effect of not reconstituting

Calf's Choice Total Gold – 60 g
Saskatoon Colostrum Co.

Lifeline Protect- 50g
APC, Inc.

Colostrum Replacements

- $25-40 USD per dose
- Lacteal or serum-derived IgG
- 100 to 150+ g IgG per dose
- Includes nutrients
- To replace maternal colostrum (MC):
  - Convenient: mix & feed
  - Use if inadequate supply of MC
  - Infectious disease control (e.g. Johne’s)
- Recommend reconstitute with water as per label

Land O’ Lakes CR – 100 g
Saskatoon Colostrum Co.

Calf’s Choice Total HiCal
100 g; Sask. Colostrum Co.

Colostrx 130 - 130g
APC, Inc.

Manufacture

- Lacteal-derived products:
  - Fresh frozen colostrum from Grade A dairies
  - Pooled, heat-treated, spray dried, packaged
  - Non-Ig components (e.g. nutrients) unchanged
  - Testing varies by manufacturer

Land O' Lakes CR – 100 g
Saskatoon Colostrum Co.

- Serum-derived products:
  - Collect blood at USDA inspected abattoirs
  - Centrifuge to separate serum, spray dry serum to 20% Ig powder,
  - No nutrients: must add nutrient pack
  - Testing varies by manufacturer

Colostrx 130 - 130g
APC, Inc.

CVB-Licensed CR or CS Products

- CFIA (all) or USDA Center for Veterinary Biologics (CVB)
- From bovine colostrum
- Can claim ‘for prevention or treatment of FPT’
- Accepted protocols for manufacture & testing
- Each batch tested by CVB lab to guarantee:
  - Purity: Specified TPC; NO Coliforms, Salmonella or fungi
  - Potency: Minimum IgG content
  - Efficacy: ≥ 10 mg/ml serum IgG) in 90% of calves
  - Traceability
- Annual plant inspection by CVB
- Some do additional testing
  (e.g. Sask. Colostrum Co. tests each batch for *M. paratuberculosis*)

Selected examples of CVB-licensed colostrum replacement (CR) or supplements (CS)

CR's

Calf's Choice
Total HiCal – 100 g
Saskatoon Colostrum Co.

Land O' Lakes CR – 100 g
Saskatoon Colostrum Co.

Land O' Lakes CR for
Kid Goats and Lambs
Saskatoon Colostrum Co.

CS's

Calf's Choice Total Gold – 60 g
Saskatoon Colostrum Co.

FIRST START 50 Bovine IgG
La Belle Associates, Inc.

Immu-Start 50 Bovine IgG
Immu-Tek

Non-Licensed CR or CS Products

- AAFCO Guidelines (Assoc. Am. Feed Control Officials):
  - Not a feed, but is being used in feeds
  - Each State (Dept. of Ag) adopts its own guidelines
- Cannot claim ‘for prevention of FPT’
- Ig may be from bovine colostrum or serum
- Internal quality testing programs at manufacturer’s discretion
- No federal/state system to regulate or test
- No product testing or plant inspections unless complaints brought to State Dept. of Ag.

Selected examples of non-licensed colostrum replacement (CR) or supplements (CS)

CR's

Lifeline Rescue,
150g; APC, Inc.

Colostrx 130
APC, Inc.

150 Benefit
La Belle Associates

First Day Formula
150g; Milk Products

CS's

Lifeline Protect,
50g; APC, Inc.

Colostrx Multi Species
20g; APC, Inc.

Ranch 40
La Belle Associates

First Day Formula
60g; Milk Products

Dose of IgG (g) Fed

- Most CR products include 100-130 g IgG (because experts originally recommended feed 100 g IgG)

  but

- Really need 150-200 g IgG if expect ≥ 90% calves to pass (serum IgG ≥ 10 mg/mL)

- How to get to 150-200 g IgG?
  - Some products provide larger dose (e.g. 150 g/dose)
  - Large tubs: Operator determines the dose
  - Manufacturer recommends feed multiple doses (e.g. if in 60 or 100 g bags)

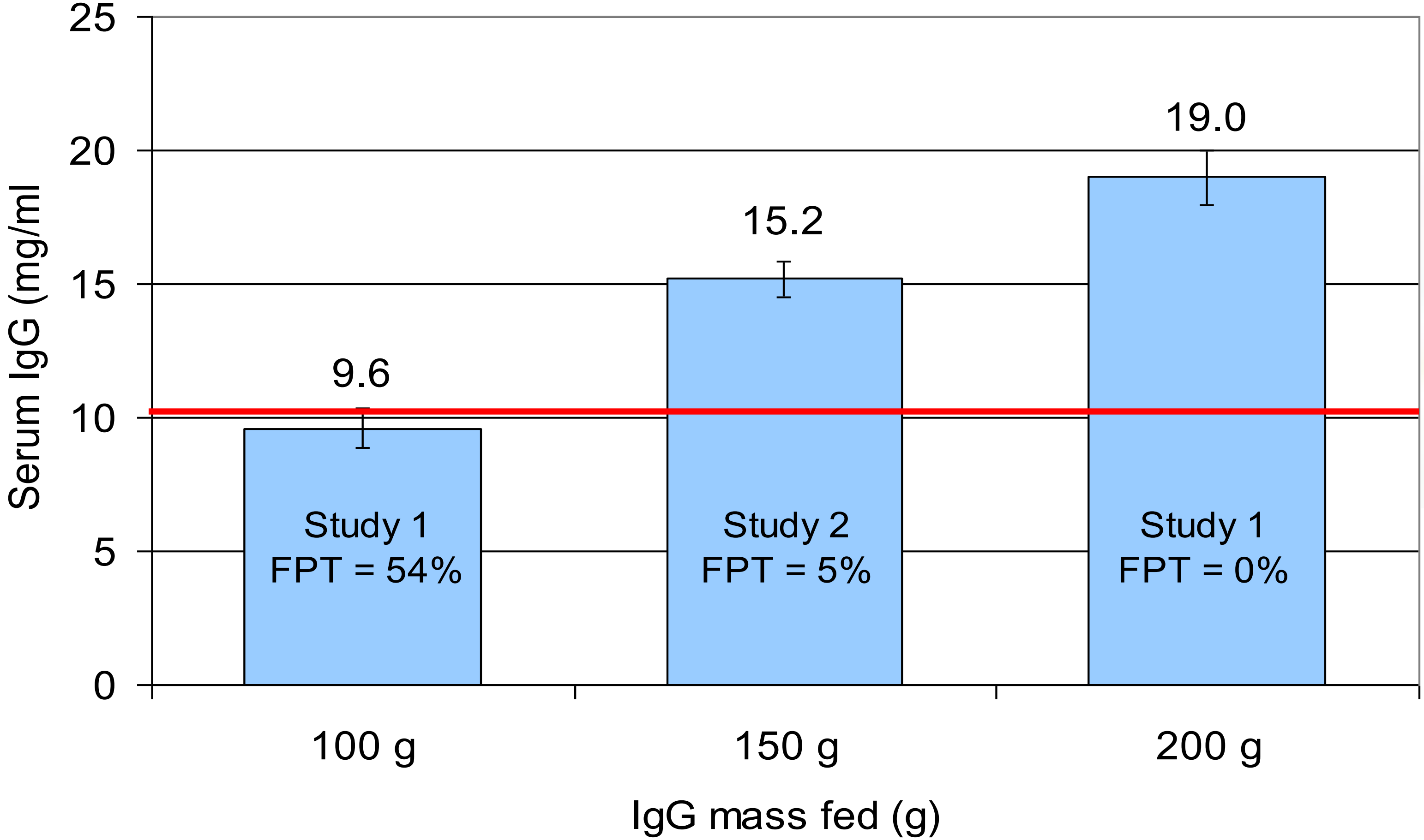
Land O' Lakes CR – 100 g
Saskatoon Colostrum Co.

Land O' Lakes CR Tub
Saskatoon Colostrum Co.

Calf's Choice Total Gold – 60 g
Saskatoon Colostrum Co.

Dose response of serum IgG to IgG mass fed

(Godden et al., 2009. JDSci. 92:1750-1757)



Conclusion: Producers wishing to reduce the risk of FPT may opt to feed higher doses IgG (150-200 g) in Colostrum Replacers

Apparent Efficiency of Absorption of IgG (%)

- AEA (%): Percentage of IgG fed which is absorbed
- Affected by many factors;
  - Age calf fed (hrs)
  - Metabolic status of calf
  - Calf weight
  - CR product: ingredients, manufacturing processes, volume, concentration of IgG (g/L)
- Is AEA (%) different…
  - MC vs CR?
  - Between CR products: e.g. Colostrum- vs serum-derived CR?
- Can <u>only</u> make comparisons in <u>head-to-head</u> trials

Sample of Colostrum Replacement Product Comparative Efficacy Studies

Study	Tx Group	IgG fed (g)	AEA (%)	Serum IgG (mg/mL)
Godden et al., JDSci 2009	MC – 3.8 L (71 g/L) LOL CR-1 dose LOL CR-2 doses	271 g 100 g 200 g	32% 36% 37%	20.7 [a] 9.6 [b] 19.0 [a]
Place et al., AABP 2010	LOL CR-1.5 doses Colostrx 130 – 1 dose	150 g 130 g	38% [a] 28% [b]	14.7 [a] 9.6 [b]
Priestley et al., JDSci 2013	MC – 3.8 L (NR) Calf's Choice Tot Silver -1 dose Acquire 150 – 1 dose	NR 100 g 150 g	NR 38.8% [a] 21.6% [b]	21 [a] 11.4 [b] 9.3 [b]

Serum IgG is a function of dose fed (g) and absorption (%)

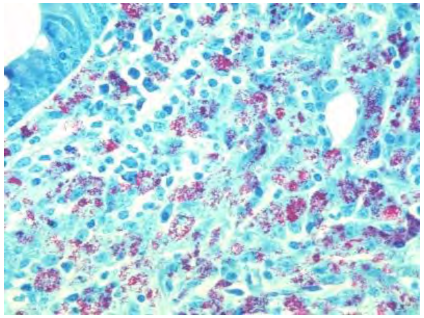
Role of Colostrum Replacements in Disease Control Programs?

- Though fecal-oral transmission is most common, MAP can be shed in colostrum and milk of subclinically infected cows

  (Sweeney et al. J.Clin.Micro. 1992. 56;
  Streeter et al., J. Clin. Micro. 1995. 30)

  – Can one feeding of colostrum cause infection with MAP?

  – Will use of a colostrum replacer prevent MAP transmission?



Risk of MAP Infection in Calves Fed Raw Colostrum or a Colostrum Replacer

(Pithua et al. 2009.J.A.V.M.A. 234:1167-1176)

Newborn heifer calves from 12 herds (N = 497)

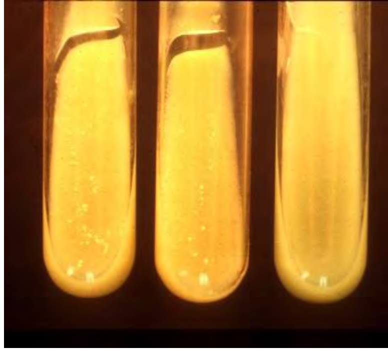
maternal colostrum (n = 261)

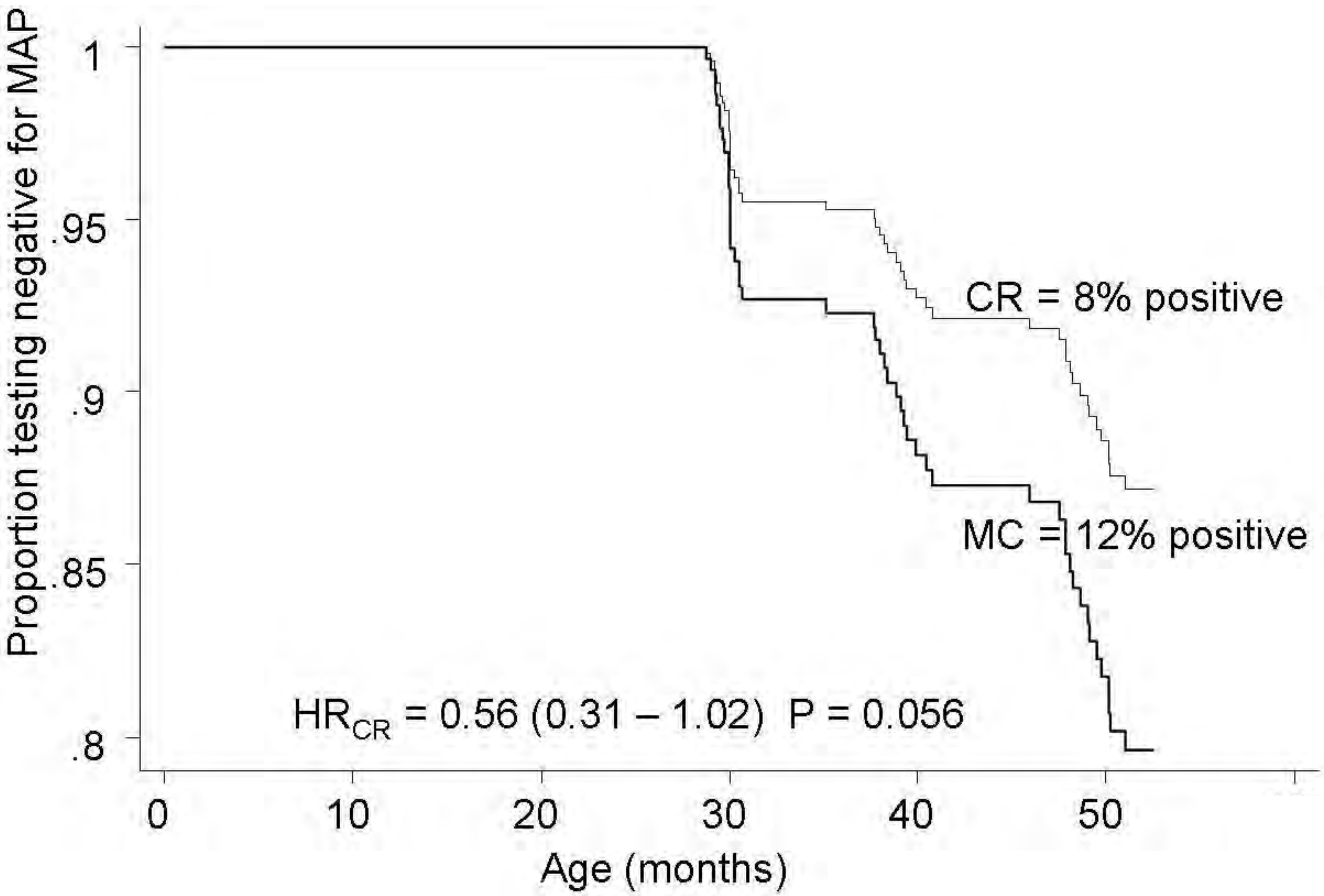
colostrum replacer (n = 236)

Acquire / Secure APC, Inc.

Adult Period: 1st calving to 54 mos:
- Fecal culture and serum ELISA for MAP at 30, 42 and 54 mos.

Results:
Calves fed a colostrum replacer had reduced risk for MAP infection





College of Veterinary Medicine
University of Minnesota

Summary on Selection and Use of Colostrum Supplements and Replacers (con't)

- Considerations in selecting a product:
  - Is the product CVB-licensed?
    - Can guarantee purity, potency, efficacy, traceability
  - Is the product serum- vs lacteal-derived?
    - Two studies suggest AEA (%) may be better in lacteal-derived CR products
  - <u>Is there independent research describing efficacy</u>?
    - IgG Dose
    - AEA (%)
    - <u>Passive transfer levels in calves</u>
- Ask for the data!!!
- Can only make direct comparisons between products in head-to-head studies

Critical Control Points to Reduce Contamination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  - Udder prep
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- Equipment
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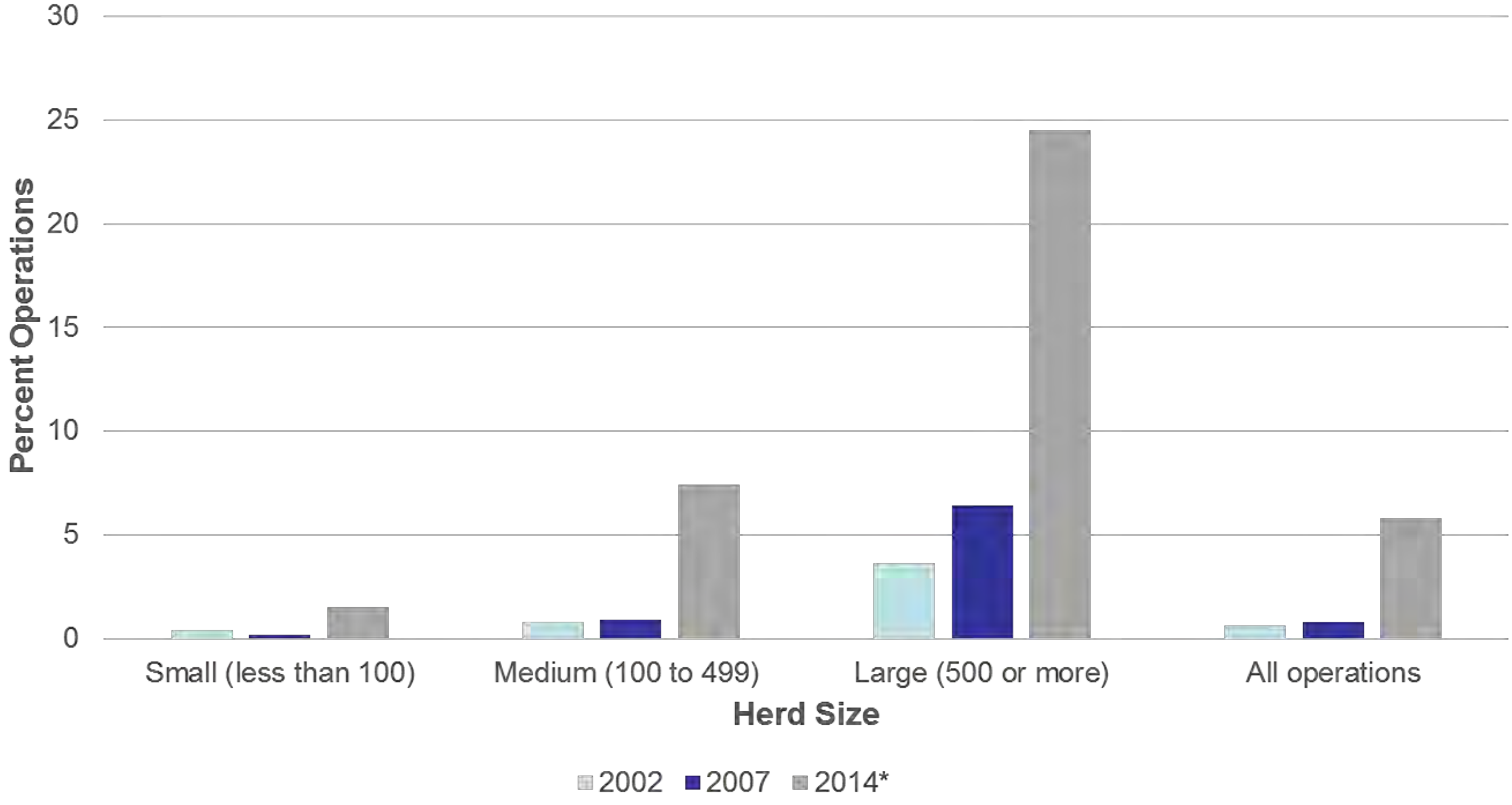
- Proliferation
  - Feed ASAP (< 1-2 hrs)
  - Refrigerate (< 48 hrs)
  - Freeze
  - Preservatives

- Replacers, Heat-treating

Effects of Heat-treating Colostrum on Colostrum Characteristics and Calf Health

Heat-treating Colostrum



NAHMS Dairy 2014

Developing a Method to Heat-treat Colostrum

- Traditional Pasteurization (PMO):
  - Continuous flow (72 °C x 15 sec) or Batch (63 °C x 30 min)
  - Unacceptable thickening
  - 25-32% loss of IgG (mg/ml)
  - Lower serum IgG in calves

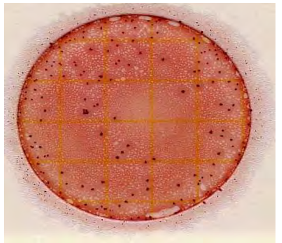
(Green et al. JDSci. 2003. 86:246;
Godden et al. JDSci. 2003. 86:1503)

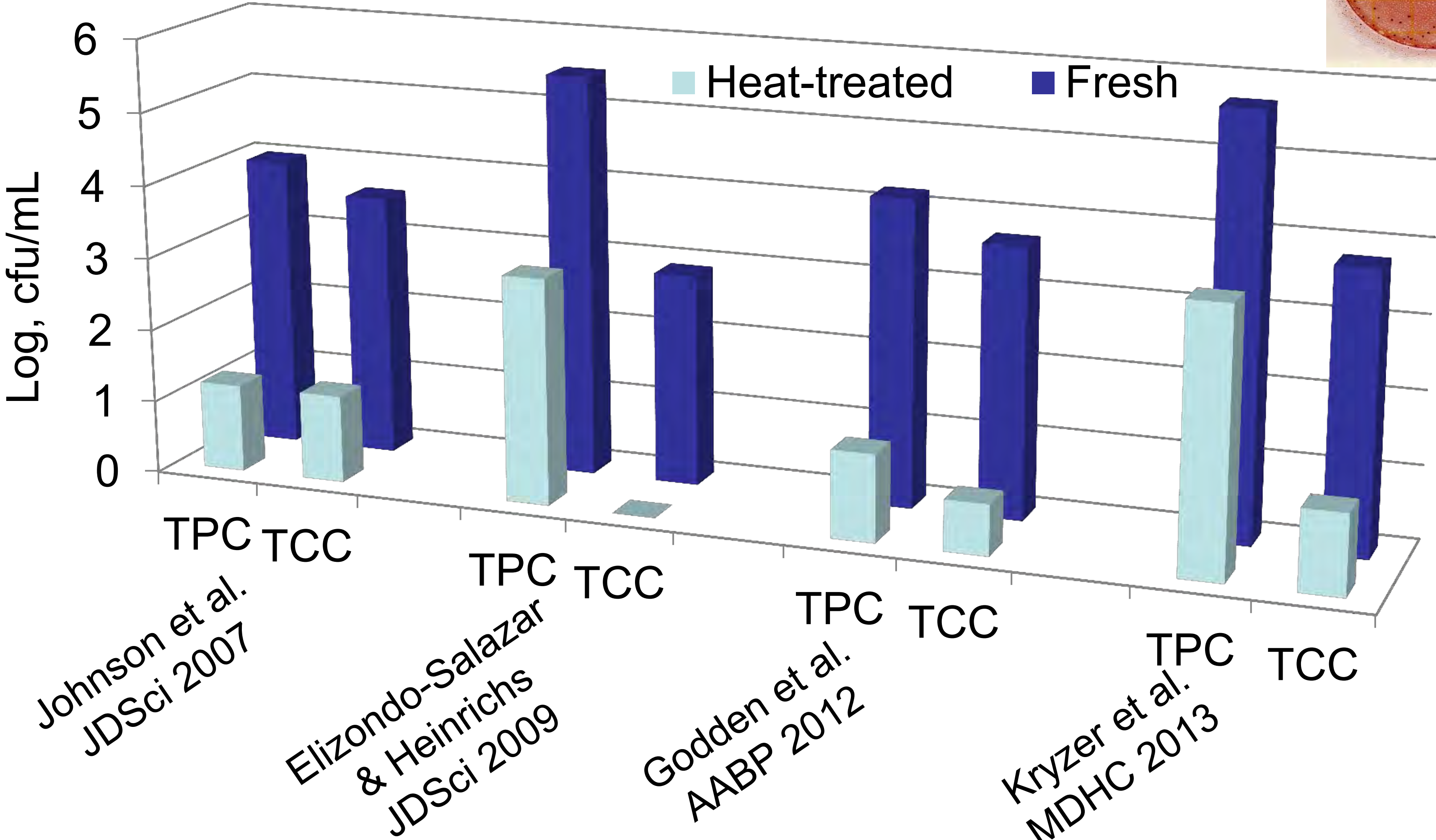
- Heat-treat: 60 °C (140 °F) x 60 min
  - No viscosity changes
  - No change in colostrum IgG (g/L)
  - Eliminate *Salmonella, Mycoplasma, E. coli*
  - Significantly reduce *M. paratuberculosis*

(McMartin et al. JDSci. 2006. 89:2110
Godden et al., JDSci. 2006. 89:3476)

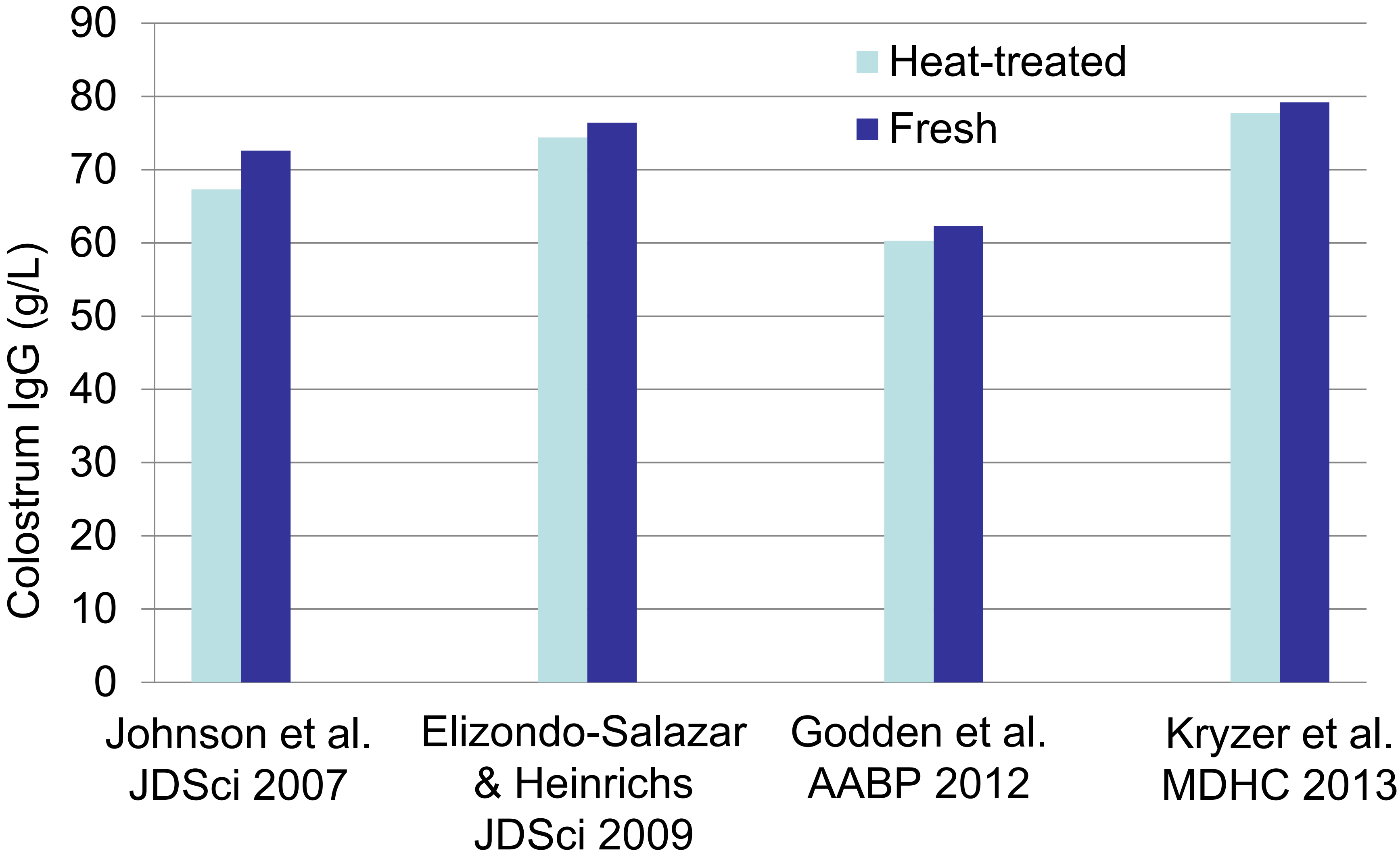
Heat-treatment reduces colostral bacteria counts

(TPC = Total Plate Count; TCC = Total Coliform Count)





No effect of heat-treatment on colostral IgG

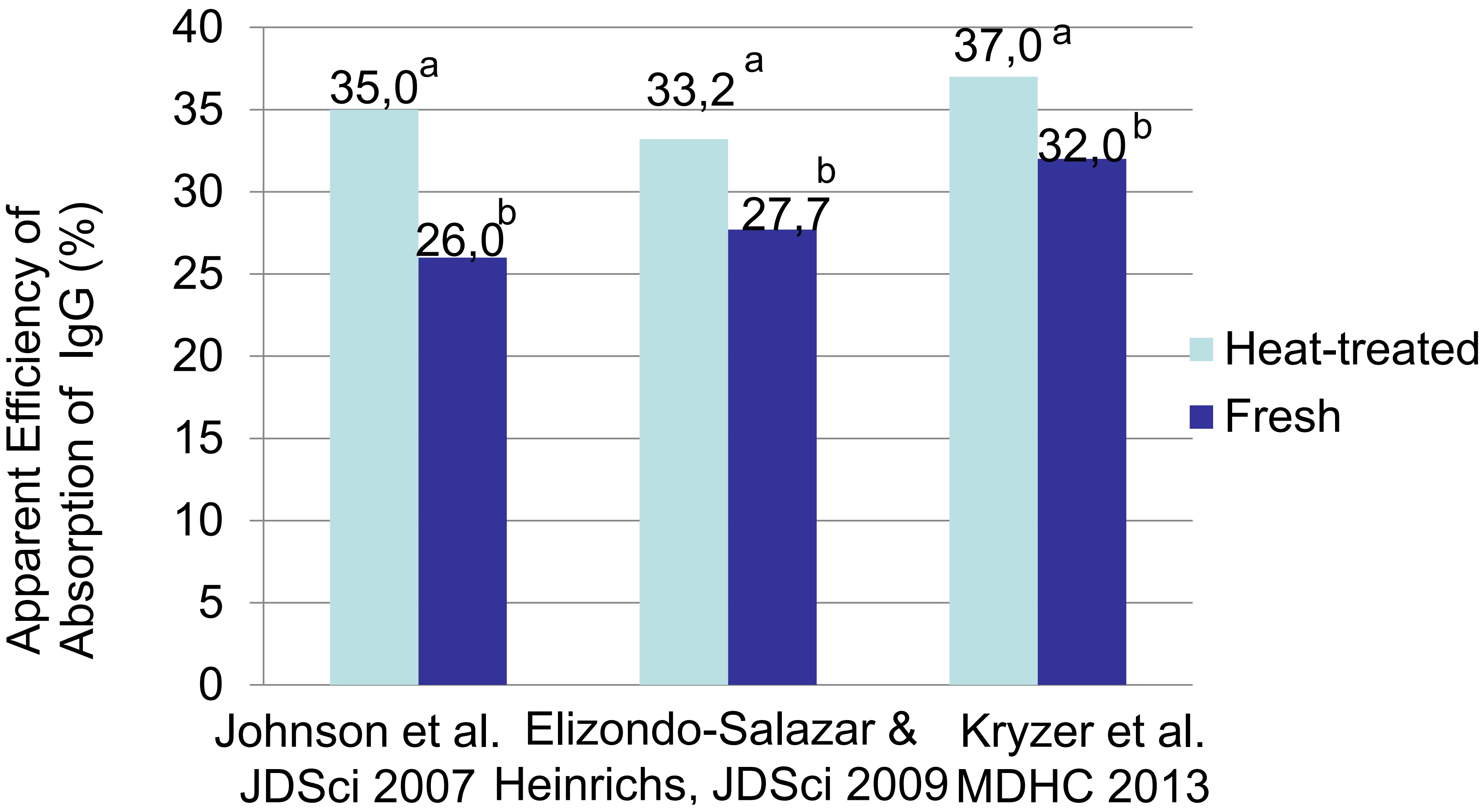


Effects of feeding heat-treated colostrum on calf health

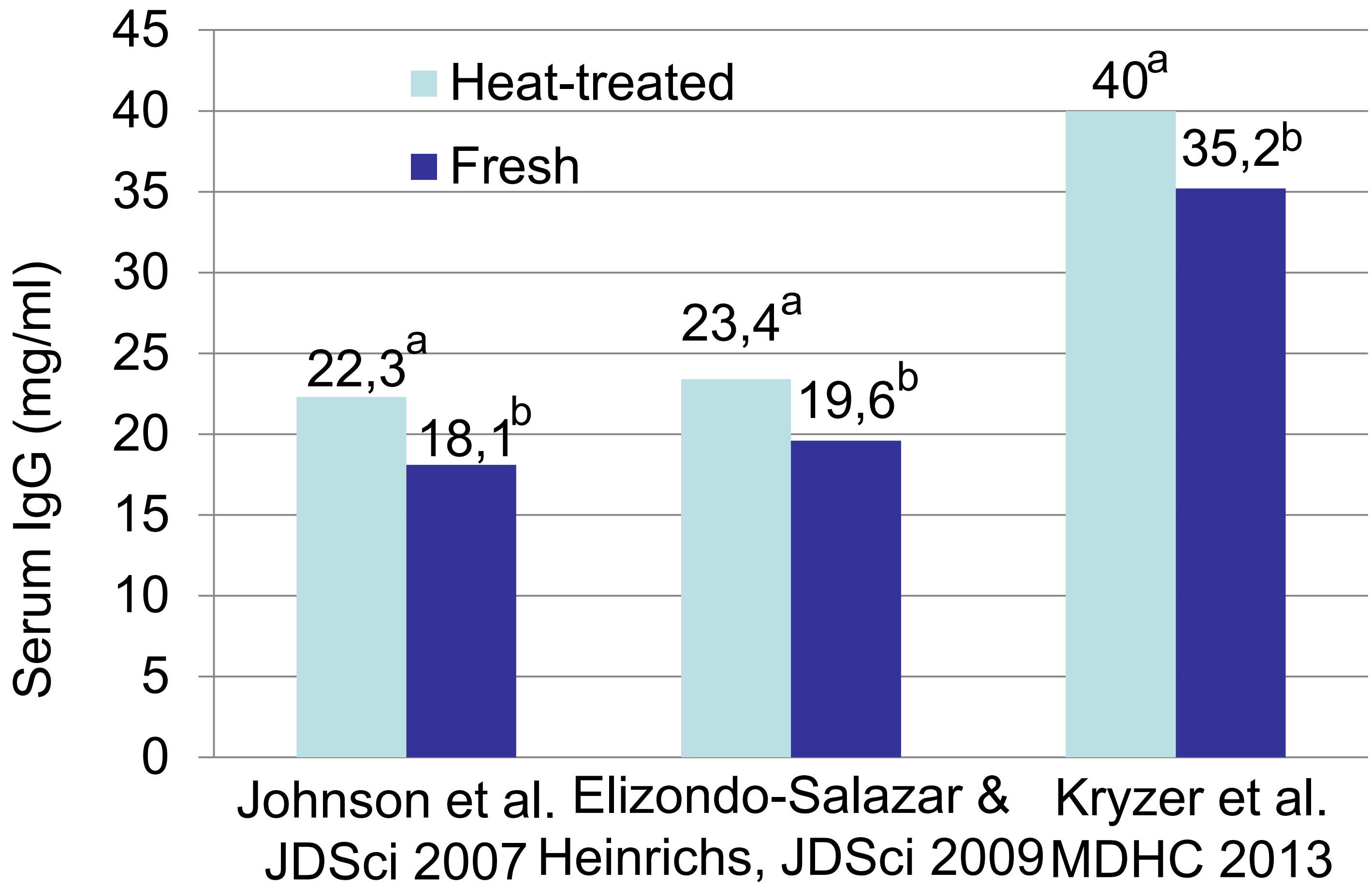
- Passive transfer of IgG
  - Apparent Efficiency of Absorption of IgG (%)
  - Serum IgG (mg/mL)

- Health
  - Morbidity
  - Mortality

Calves fed heat-treated colostrum have improved efficiency of absorption of IgG (%)



Calves fed heat-treated colostrum have increased serum IgG concentrations (mg/ml)

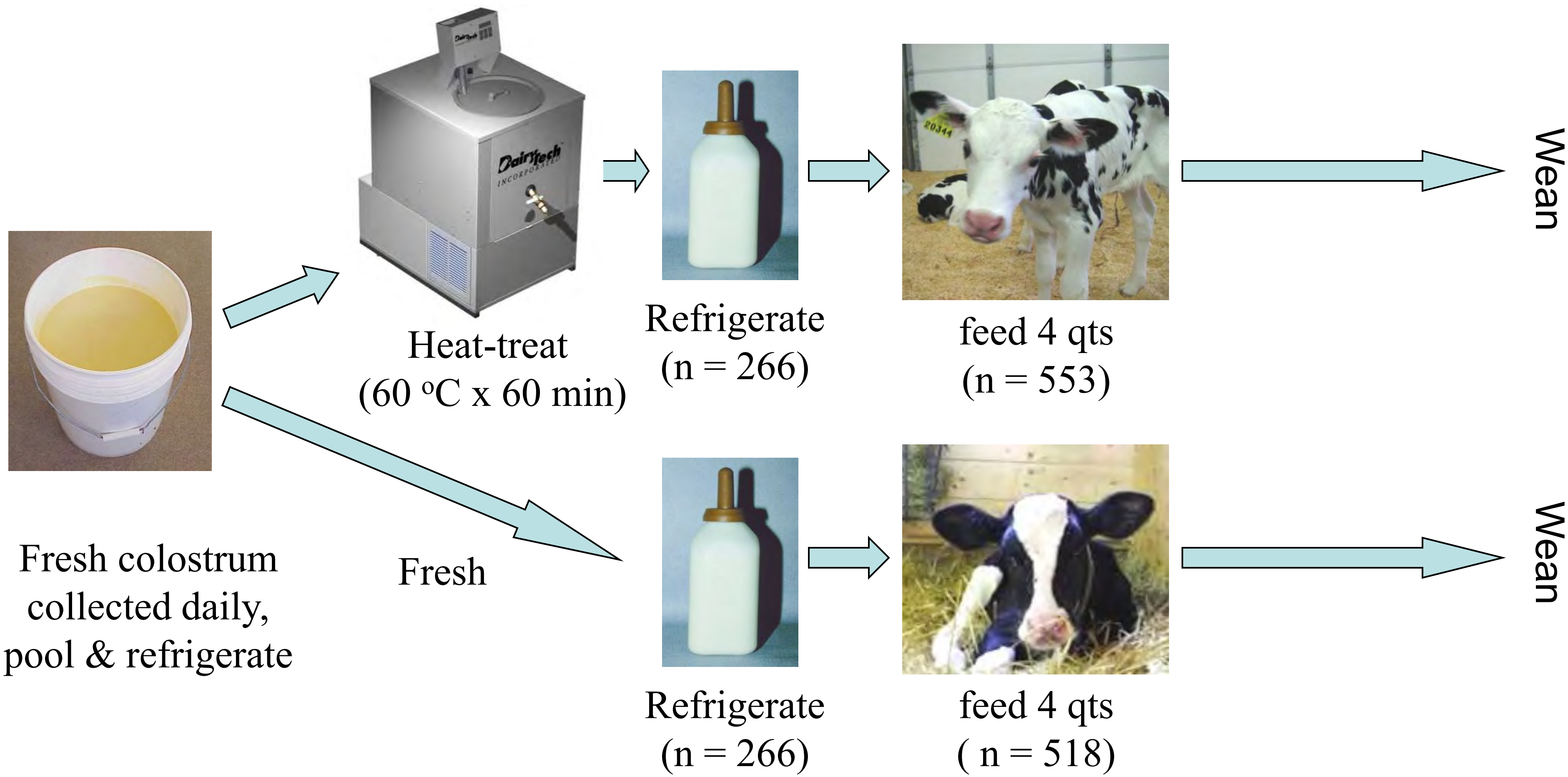


So What?!

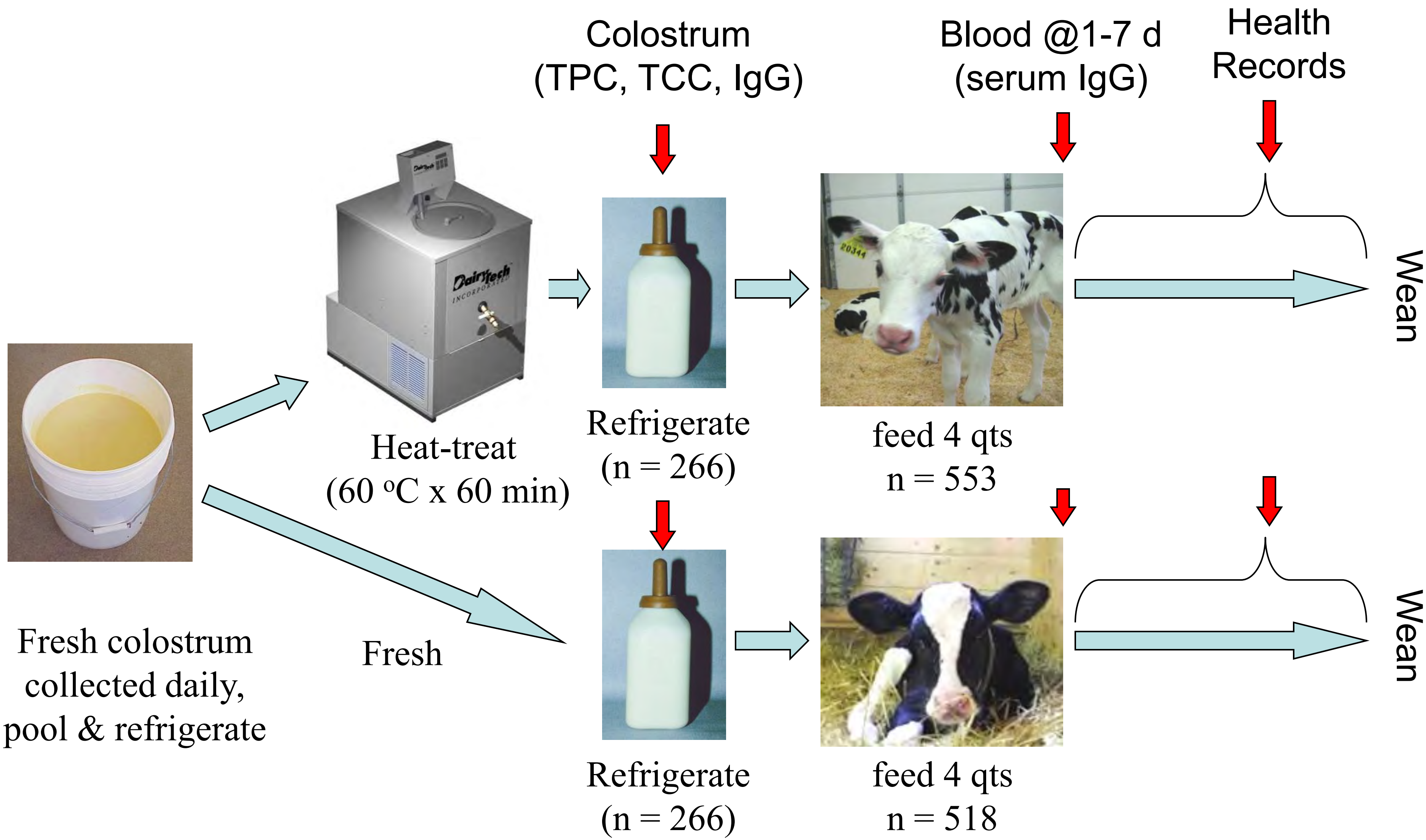
…Will we have healthier calves?
…Will it control Johne's Disease?

Methods: Calf Enrollment

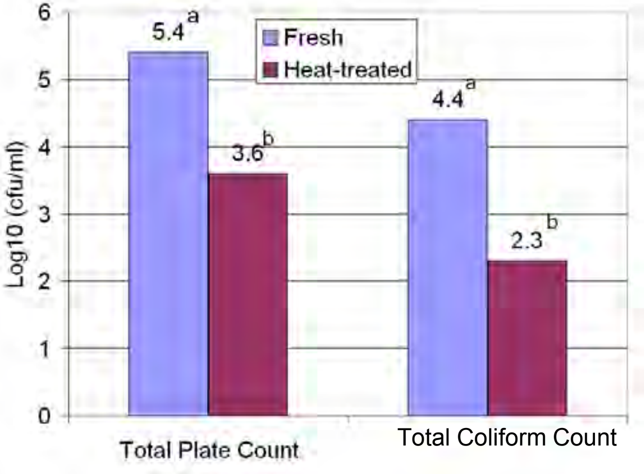
- Summer, 2007
- 6 large commercial herds (MN, WI)



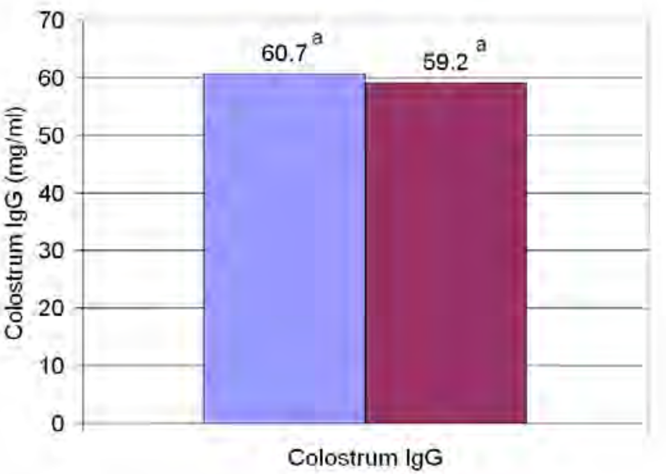
Methods: Sample / Data Collection



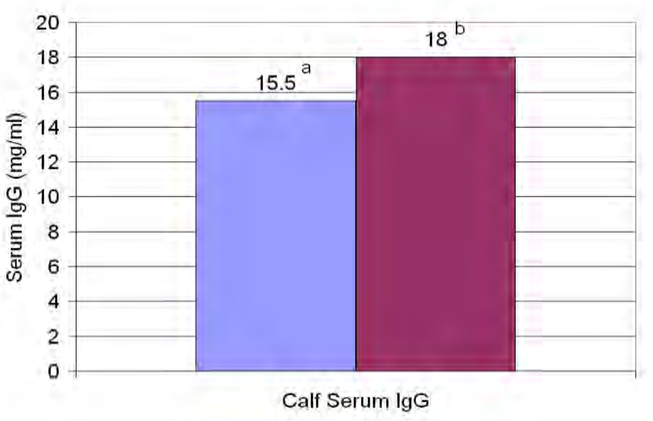
Results



↓ Total Plate Count (TPC) and
↓ Total Coliform Count (TCC)



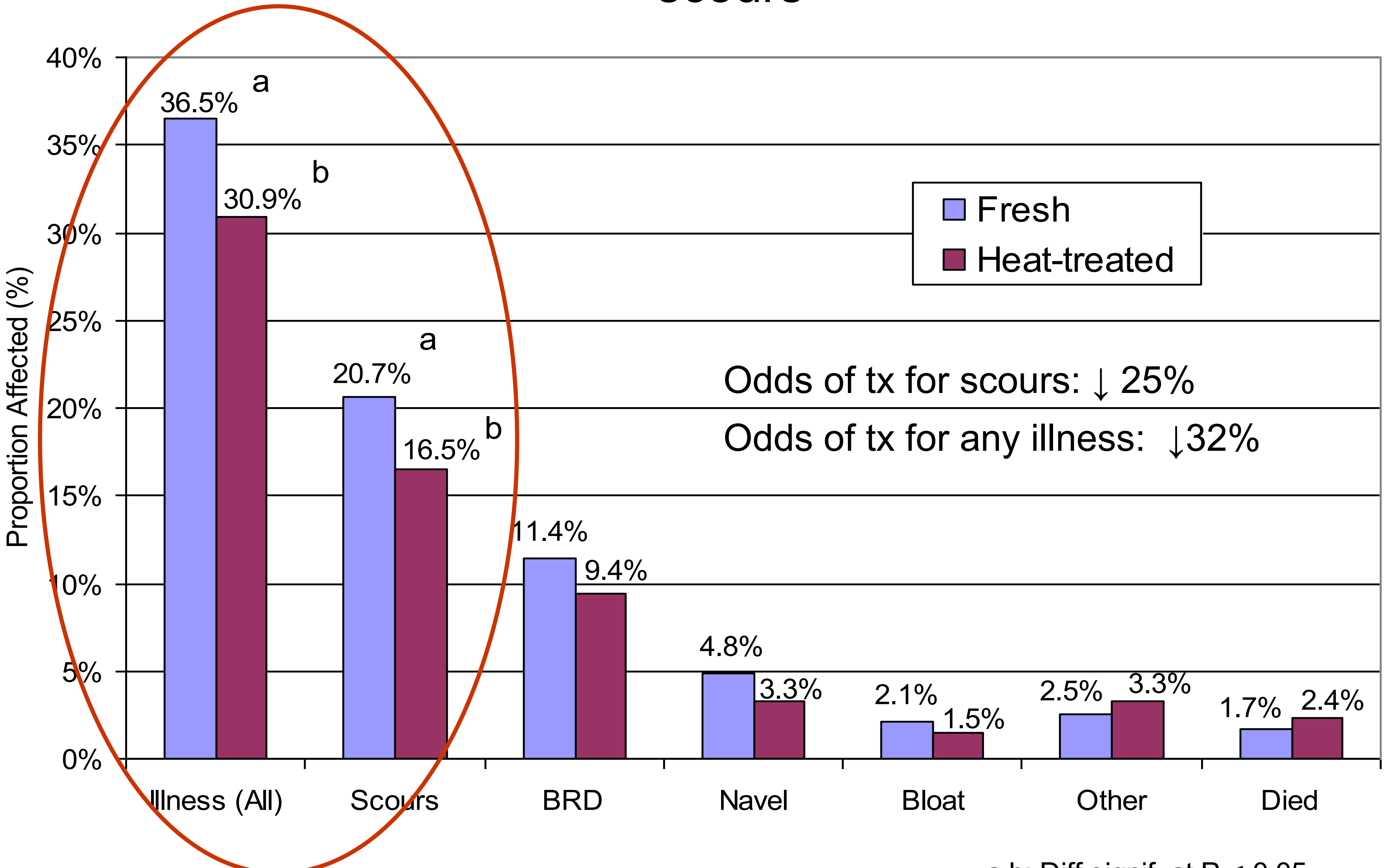
No overall effect on colostrum IgG (g/L)



Increased calf serum IgG (mg/ml)

Results: Calf health was improved

Decreased risk for treatment (all causes) or treatment for scours

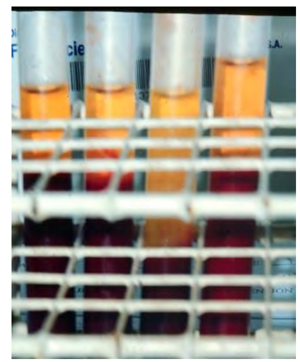


a,b: Diff signif. at $P < 0.05$

Results of Path Analysis

Heat-treat colostrum

↓ Colostrum coliform count



↑ Serum IgG (mg/ml)

Healthier calf

Effects of feeding heat-treated colostrum on long-term health and performance

(Godden et al., JDSci. 2015)

- Cows followed for 5 years (61 mos)
- Tested annually (L1, L2, L3) for MAP using serum ELISA and fecal culture
- Collected DHIA records: milk, culling

Parameter	Fresh	Heat-treated	P value
Num. originally enrolled	518	553	
MAP Positive (%)	9.0 %	8.6 %	0.24
Culled from herd (%)	72%	68%	0.08
Total Milk in L1 + L2 (kg)	20,330	20,708	0.57

Conclusions: were some positive trends but no significant effect of treatment

Question: Why did heat-treatment not reduce the risk for MAP?

Possible answers:

1. Was MAP exposure too little to matter? (only 15% of batches PCR+ for MAP)
2. Other sources of exposure overwhelmed treatment effect?
3. Heat-treatment protocol doesn't work?

Evaluation of the Perfect Udder System (from DairyTech) for Heat-treating Colostrum

(Kryzer et al., AABP 2013)

- Summer, 2012
  - 30 batches of colostrum
  - 120 Jersey calves
- Treatments compared:
  - Heat-treated in batch
  - Heat-treated in PU bag
  - Fresh colostrum
- Results: Heat-treating in PU bag performed equally well to batch when evaluating colostrum and calves

Summary:
Effects of heat-treating colostrum

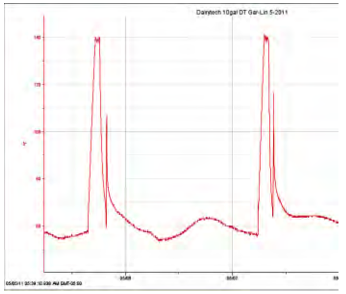
- Colostrum characteristics:
  - ↓ colostrum bacteria counts
  - Preserves IgG, nutrients, non-specific immune factors
  - ↓ viability of WBC: *Significance TBD*

- Animal health:
  - ↑ serum IgG levels (mg/mL)
  - ↓ preweaning morbidity (esp. scours)
  - No significant effect on adult health and performance

“Must do’s” to heat-treat colostrum

- Methods:
  - Batch design or Perfect Udder System (DairyTech, Inc.)
  - NOT Ultraviolet treatment: 43% loss of IgG
    (Teixeira et al., The Vet J. 2013 *in press*)

- Constant agitation
- Active (not passive) heating and cooling
- Monitoring:
  - Times & temps:
    - 60 ºC x 60 minutes: No fluctuations above 61 ºC
  - Periodic culture of heat-treated colostrum:
    - TPC < 20,000 cfu/ml (?); TCC < 1,000 cfu/ml (?)
  - Calves: STP, morbidity, mortality



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The 5 Q's of Colostrum Management

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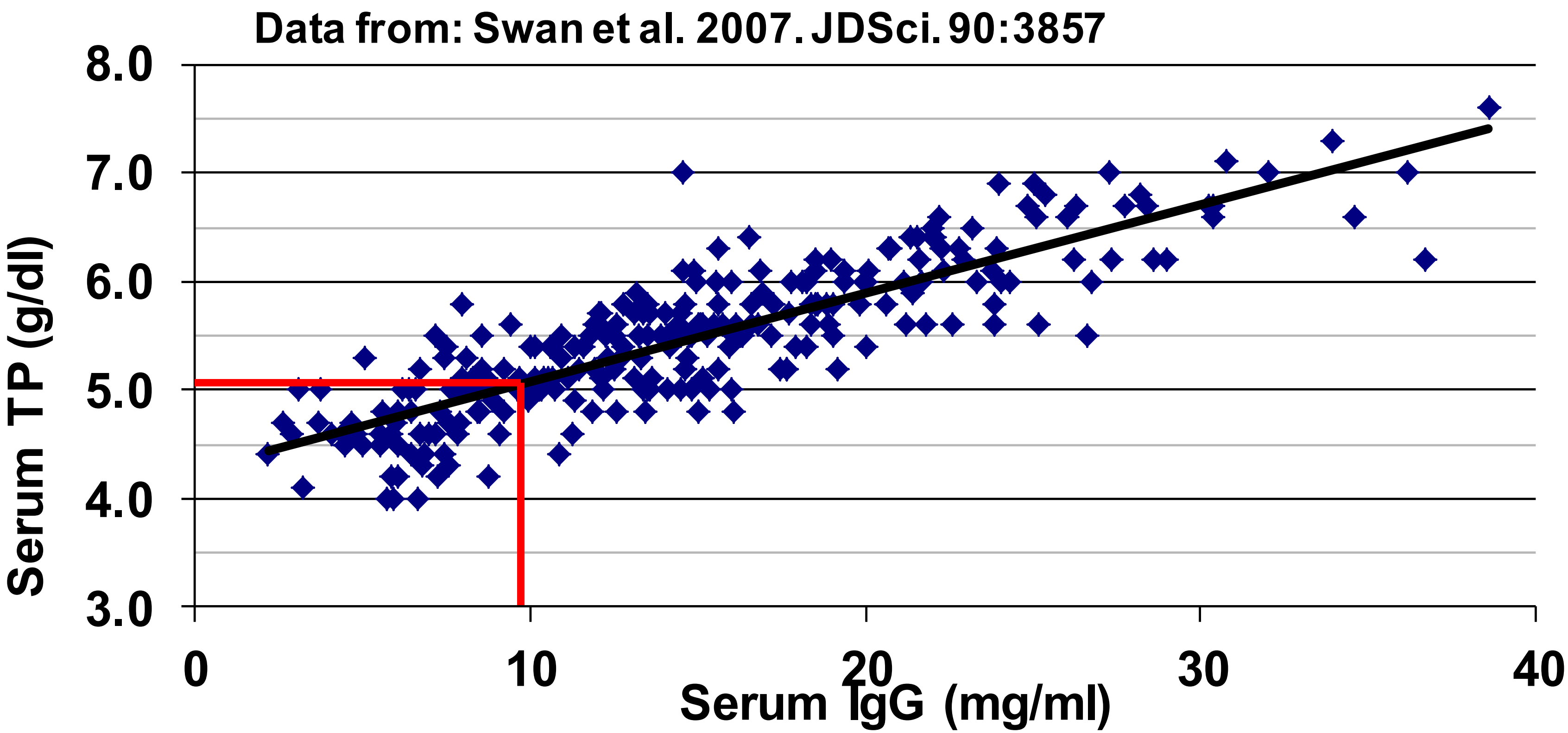
- **Q**uantity: 10% of Birth Weight
- **Q**uickness: ASAP (1-6 hrs)
- S**Q**ueeky clean: TPC < 100,000 cfu/ml
- **Q**uantifying passive transfer (monitoring)

On-farm monitoring of serum total protein to evaluate the colostrum program

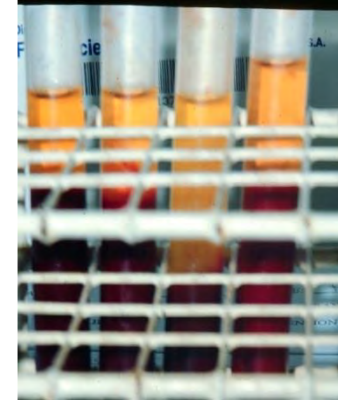
refractometer



- 5.0 or 5.2 g/dL STP value to predict serum IgG of 10 mg/ml:

(Calloway, et al., 2002)

5. Monitoring passive transfer rates



- Herd level:
  – Bleed 12+ clinically normal 1-7 d old calves & separate serum

- STP Refractometer:
  - Goal: 90% ≥ 5.2 g/dL
    or 80% ≥ 5.5 g/dL

- Brix Refractometer:
  - Goal: 90% ≥ 8.4%

Monitoring Serum Total Protein Measures when Feeding Colostrum Replacers

- Maternal colostrum:
  - STP 5.0 or 5.2 g/dL ≈ 10 g/L IgG
- Colostrum-derived colostrum replacers *(some exceptions):*
  - STP 5.0 or 5.2 g/dL ≈ 10 g/L IgG
- Serum-derived colostrum replacers:
  - STP ??? = 10 g/L IgG
  - STP values vary between 4.2 to 5.4 g/dL between studies and products:
    - e.g. 4.75 g/dL for Colostrx 130 (Place et al., 2010)
  - If STP values are not published for a specific product, do direct testing of IgG (ELISA, RID, zinc sulfate-turbidity)

The 5 Q's of Colostrum Management

- **Q**uality: > 50 g/L IgG
- **Q**uantity: 10% of Birth Weight
- **Q**uickness: ASAP (1-6 hrs)
- S**Q**ueeky clean: TPC < 100,000 cfu/ml
- **Q**uantifying passive transfer: monitor STP

How is our industry doing at colostrum management?

	Goal	Current Reality
Quality	> 50 g/L IgG	
Quantity	3-4 L (10 % BWt)	
Quickness	1-2 hr (6 max)	
Cleanliness	< 100,000 TPC	
FPT Rates	< 10%	

How is our industry doing at colostrum management?

	Goal	Current Reality
Quality	> 50 g/L IgG	US: ≈ 15.5% farms test w colostrometer or brix [1]
Quantity	3-4 L (10% BWt)	US: 87% of farms gave ≥ 4 qts within 24 hrs [1]
Quickness	1-2 hr (6 max)	US: Avg. 3.6 hrs old at first feeding [1]
Cleanliness	< 100,000 TPC	US: 43% of samples failed [4]
FPT Rates	< 10%	US: 14% [1]

[1] NAHMS 2014; [4] Morrill et al., JDSci, 2014;

How is our industry doing at colostrum management?

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FPT Rates	< 10%	US: 14% [1]

We have an opportunity!

[1] NAHMS 2014; [4] Morrill et al., JDSci, 2014;

Summary

- Opportunity for veterinarians to help producers improve calf health and future performance through colostrum management

- 5 Q's of colostrum management:
  - **Q**uality: > 50 g/L IgG
  - **Q**uantity: 10% of Birth Weight
  - **Q**uickness: ASAP (1-6 hrs)
  - S**Q**ueeky clean: TPC < 100,000 cfu/ml
  - **Q**uantifying passive transfer: monitor STP

College of Veterinary Medicine
University of Minnesota

Thank you!

Questions?

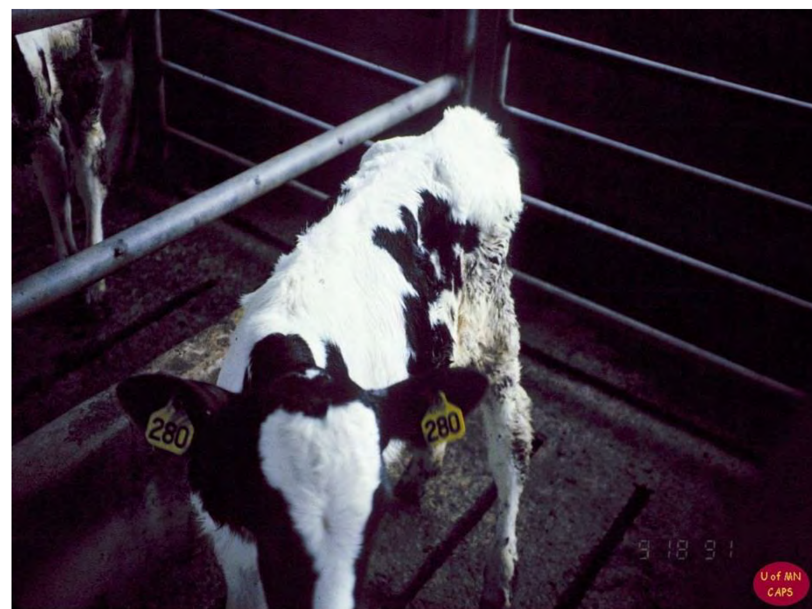
Detection, Diagnosis and Treatment of Disease in Calves

Sandra Godden DVM, DVSc
College of Veterinary Medicine
University of Minnesota

Calfhood disease results in economic loss due to:

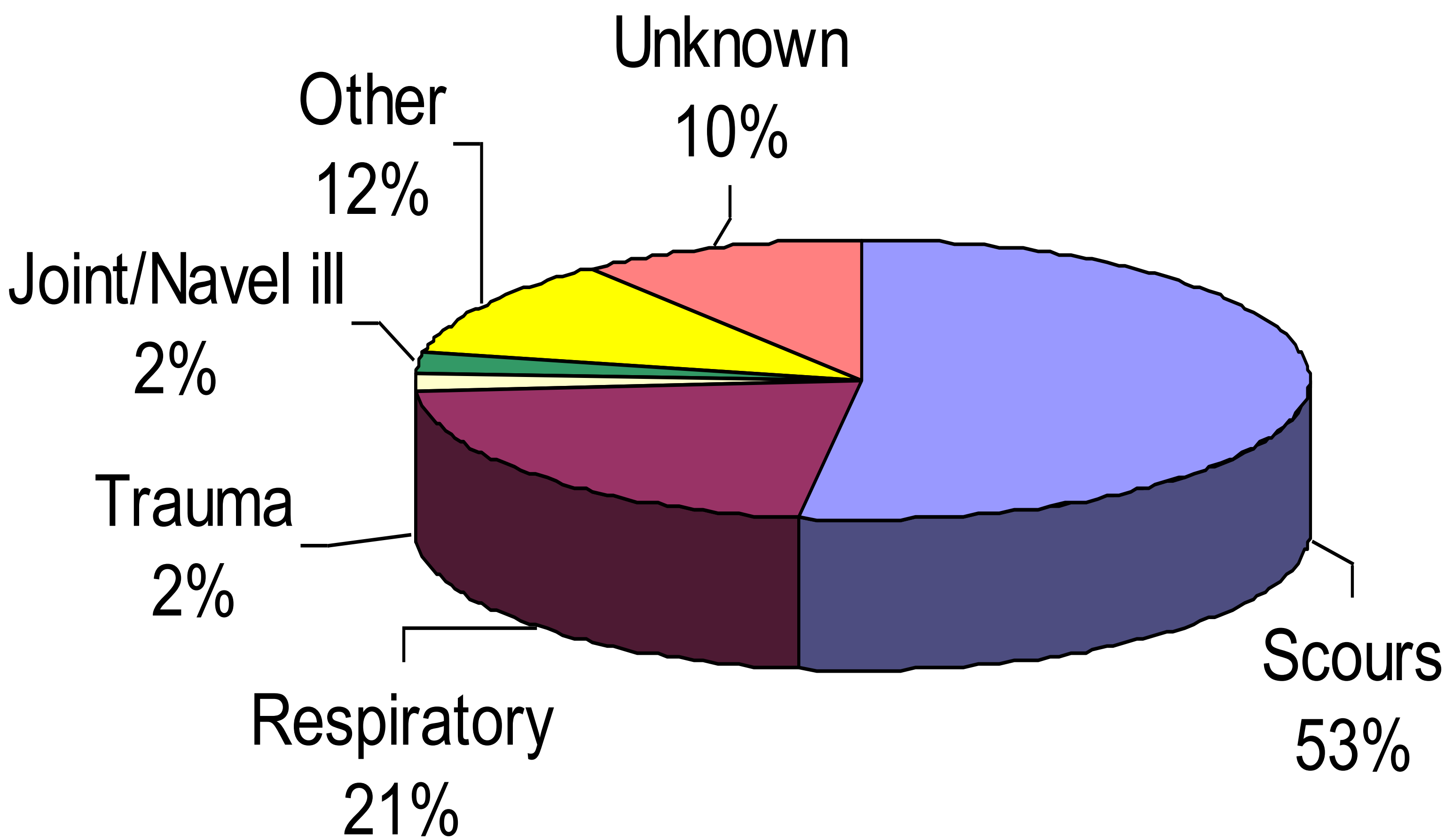
- Acute (clinical) disease
  - Treatment costs
  - Death loss
  - Replacement costs
  - Genetic loss

- Subclinical disease
  - Impaired future performance



Preweaning Mortality Rates in Heifers

7.8 – 10.8 % mortality rate (NAHMS, 1993, 1996, 2007)



What are our goals for health?

Parameter	24 hrs – 60 days	61 – 120 days	121 to 180 days
Mortality Rate (%)	< 5%	< 2%	< 1%
Scours Rate (%)	< 25%	< 2%	< 1%
Pneumonia Rate (%)	< 10%	< 15%	< 2%

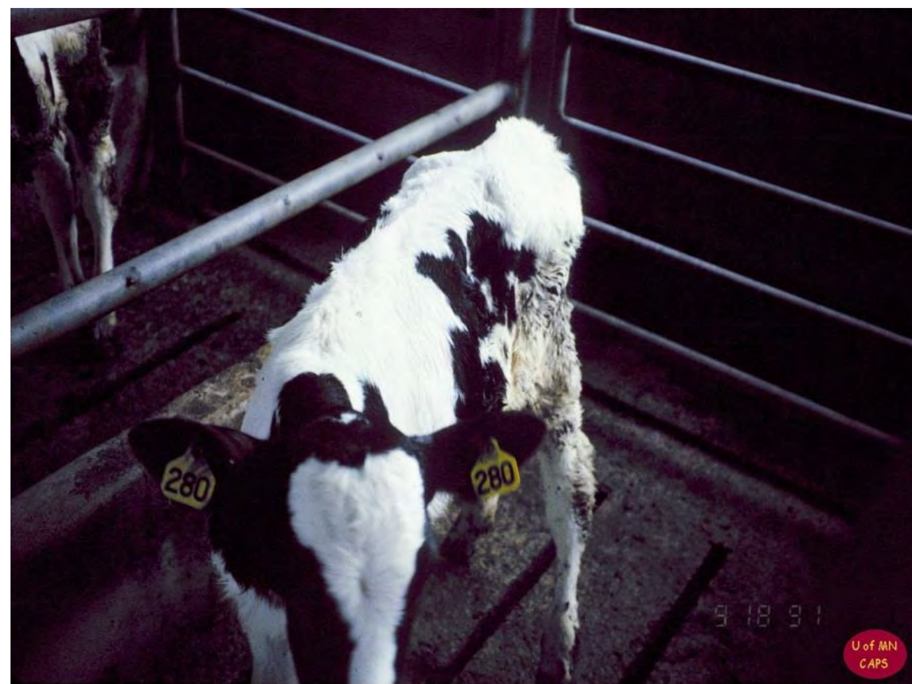
Dairy Calf and Heifer Association Gold Standards
(www.calfandheifer.org)

Outline

- Daily screening process – detect, diagnosis and treatment of sick calves
- Causes, diagnosis and treatment of specific diseases:
  - Scours
  - Pneumonia
  - Mycoplasma
  - Salmonellosis

Daily screening to detect, diagnose and treat sick calves

- Early detection is more effective than treatment
- Process:
  - Detection
  - Diagnosis
  - Treatment
  - Records (Monitor)



Detecting Disease

- Daily observation
- Accomplished during other chores (e.g. feeding milk, water, grain)
- Look for:
  - Calves slow to get up for feed
  - Calves not finishing or slow to finish milk
  - Calves still standing when most others are lying down

Images from Sheila McGuirk

Mark calves/pens that need a full exam

Clothes pin identifies pen for exam

Image from Sheila McGuirk

Diagnosis and Treatment Teams

- It takes a trained team

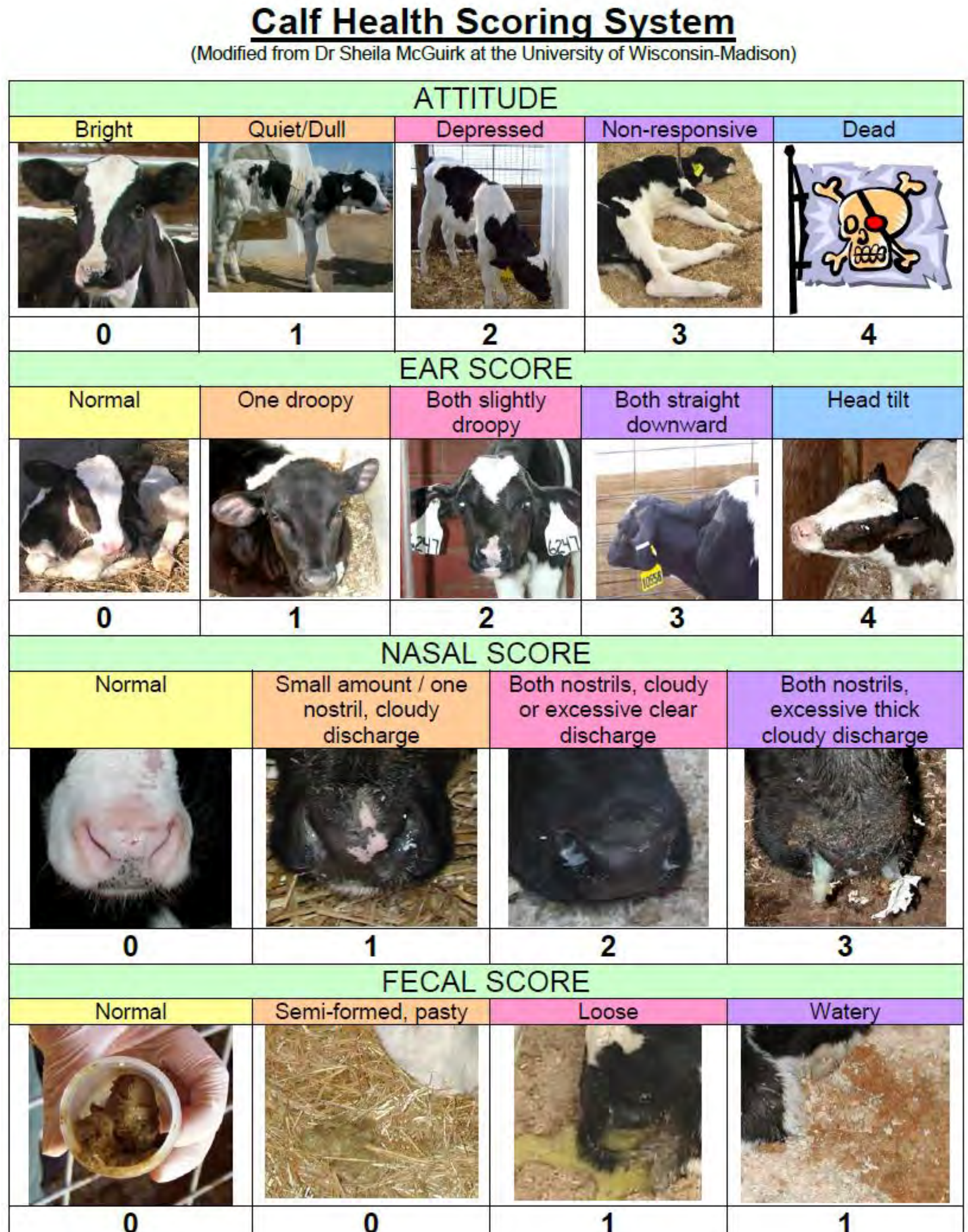
- Labor:
  - 1 FTE/100 calves for routine chores

  - 0.5/100 calves for health management tasks

Full exam by highly trained workers

Observation	Abnormal
Temperature	< 37.8 °C (100 °F) or > 39.5 °C (103 °F)
Head position	Tilted, star gazing, dropped or extended
Discharge	Eyes or ears
Nasal discharge	Color and amount
Cough	Spontaneous or induced
Breathing pattern	Rapid, grunting, abdominal effort (snap)
Navel	Thick, painful or hot, discharge or bad smell
Legs	Lame, won’t get up, swelling, crooked
Feces	Loose, watery, blood

Twice weekly health scoring



Calf Health Scoring System

(Modified from Dr Sheila McGuirk at the University of Wisconsin-Madison)

ATTITUDE				
Bright	Quiet/Dull	Depressed	Non-responsive	Dead
0	1	2	3	4

EAR SCORE				
Normal	One droopy	Both slightly droopy	Both straight downward	Head tilt
0	1	2	3	4

NASAL SCORE			
Normal	Small amount / one nostril, cloudy discharge	Both nostrils, cloudy or excessive clear discharge	Both nostrils, excessive thick cloudy discharge
0	1	2	3

FECAL SCORE			
Normal	Semi-formed, pasty	Loose	Watery
0	0	1	1

Twice weekly health scoring chart

Calf Health Scoring Chart

Farm Name: ________________________________

Date: ______________________

Calf Scores (Total respiratory score: 4 – watch, 5 or more – treat; fecal score: 2 or 3 –treat)							
Animal ID	Age	Temp-erature	Nasal discharge	Cough – spontaneous or induced	Eye or ear	Total respiratory score	Fecal consistency

Scoring Chart from Sheila McGuirk

Treatments Needed

- Written protocols from a veterinarian who is actively involved by participation, training and monitoring results
- Treatment crew with:
  - Good skills
  - Cares about animals
  - Patience
- Manager who leads by example
- Communication is essential:
  - Detection crew => exam crew
    => treatment crew => manager => records

Stall side markers helps

Slide from Sheila McGuirk

Communicating Treatment Status

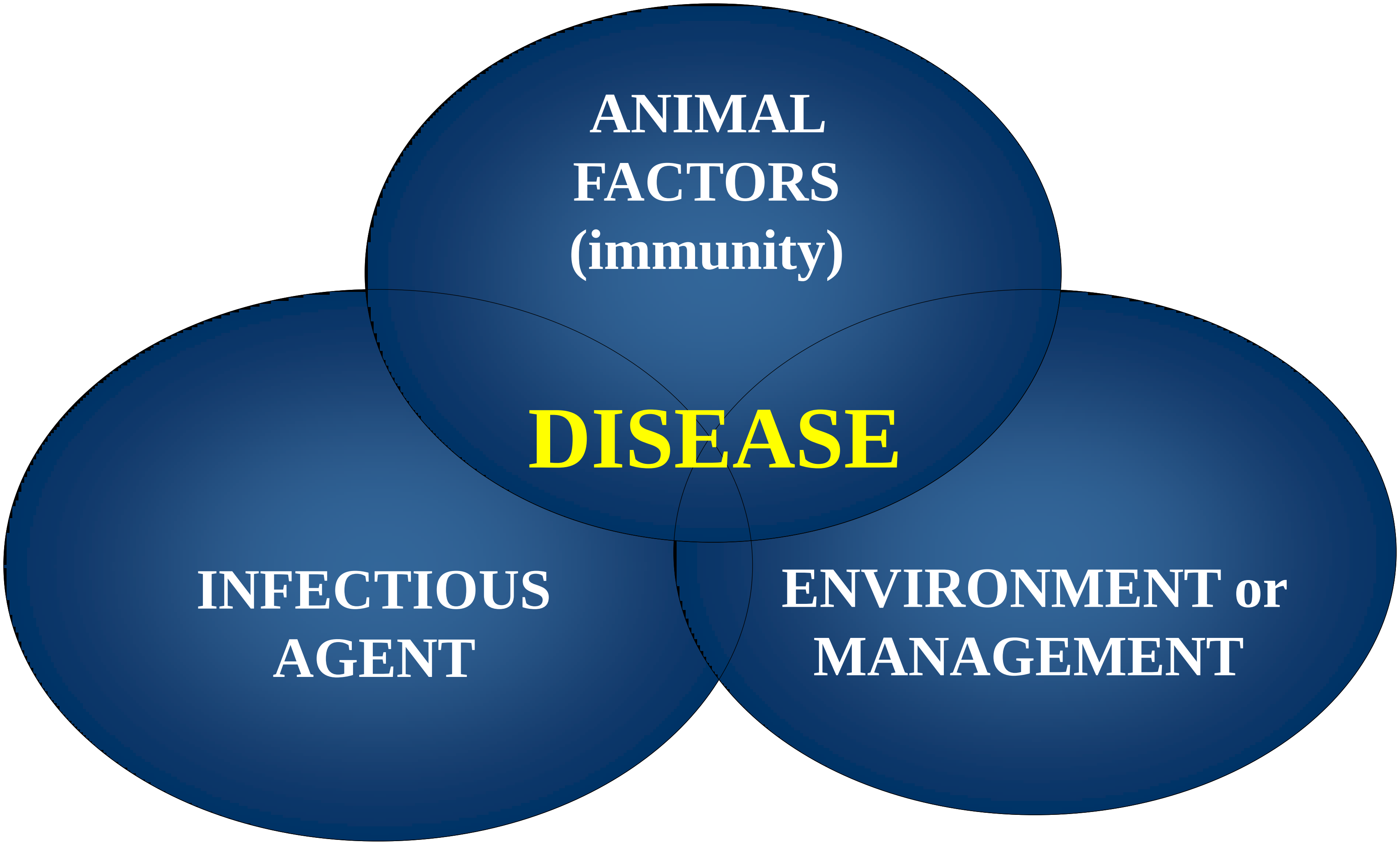
Slide from Sheila McGuirk

Outline

- Daily screening process to detect, diagnoseand treat sick calves
- Causes, diagnosis and treatment of specific diseases
  - Scours
  - Pneumonia
  - Mycoplasma
  - Salmonellosis

Calf Scours

Multifactorial Disease



Scours: Common Infectious Agents

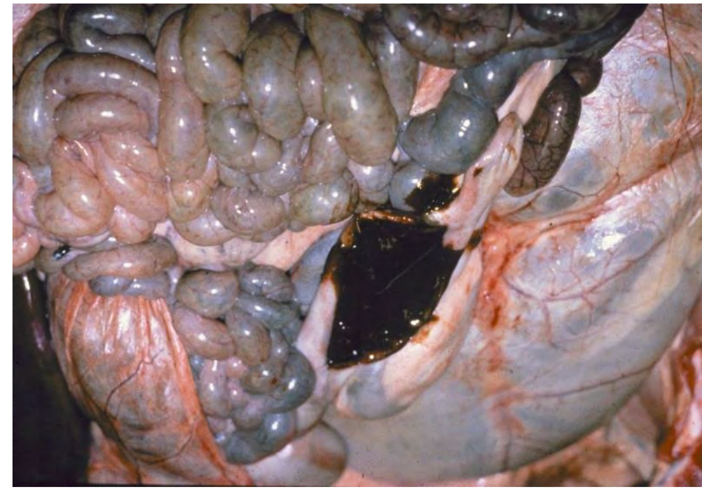
- Bacteria:
  - *E. coli*
  - *Salmonella* spp.
  - *Clostridium perfringens* Type C
- Viruses:
  - *Rotavirus*
  - *Coronavirus*
  - Bovine Viral Diarrhea (BVD)
- Protozoal parasites:
  - *Eimeria* spp. (Coccidiosis)
  - *Cryptosporidium parvum*

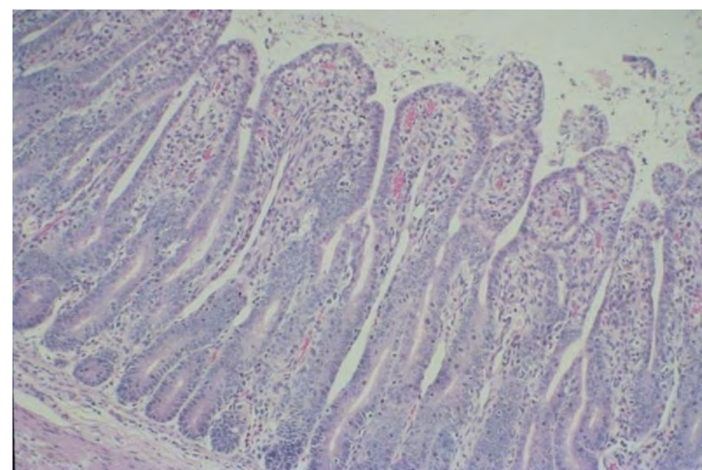
Agent	Age	Transmission	Comments
E. coli	< 3 d	fecal-oral	Rapid death < 24 hr. Aggressive fluid support
Salmonella	1 to 6 wk (any age)	fecal-oral colostrum/milk saliva/nasal in-utero	Can lead to septicemia Antibiotics, fluids
Rotavirus	5 to 15 d	fecal-oral	Damage to villi fluid support
Coronavirus	5 to 21 d	fecal-oral	Damage to villi fluid support

Agent	Age	Transmission	Comments
Bovine Viral Diarrhea (BVD)	any age	fecal-oral colostrum/milk saliva/nasal in-utero (P.I.)	< 2% calves born P.I. only 10 % survive to 2 yrs. Less common cause scours Resp. dz, abortion, death Type 1 & II
Coccidiosis (eimeria spp)	> 17 d	fecal-oral	Treat: fluids, Corid® (amprol) Prevention: - Sanitation *** - Deccox ® (decoquinate) - Bovatec ® (lasalocid) - Rumensin ® (monension)
Cryptosporidium	5 - 35 d	fecal-oral	Resistant to antibiotics & most disinfectants. Sanitation/supportive fluids

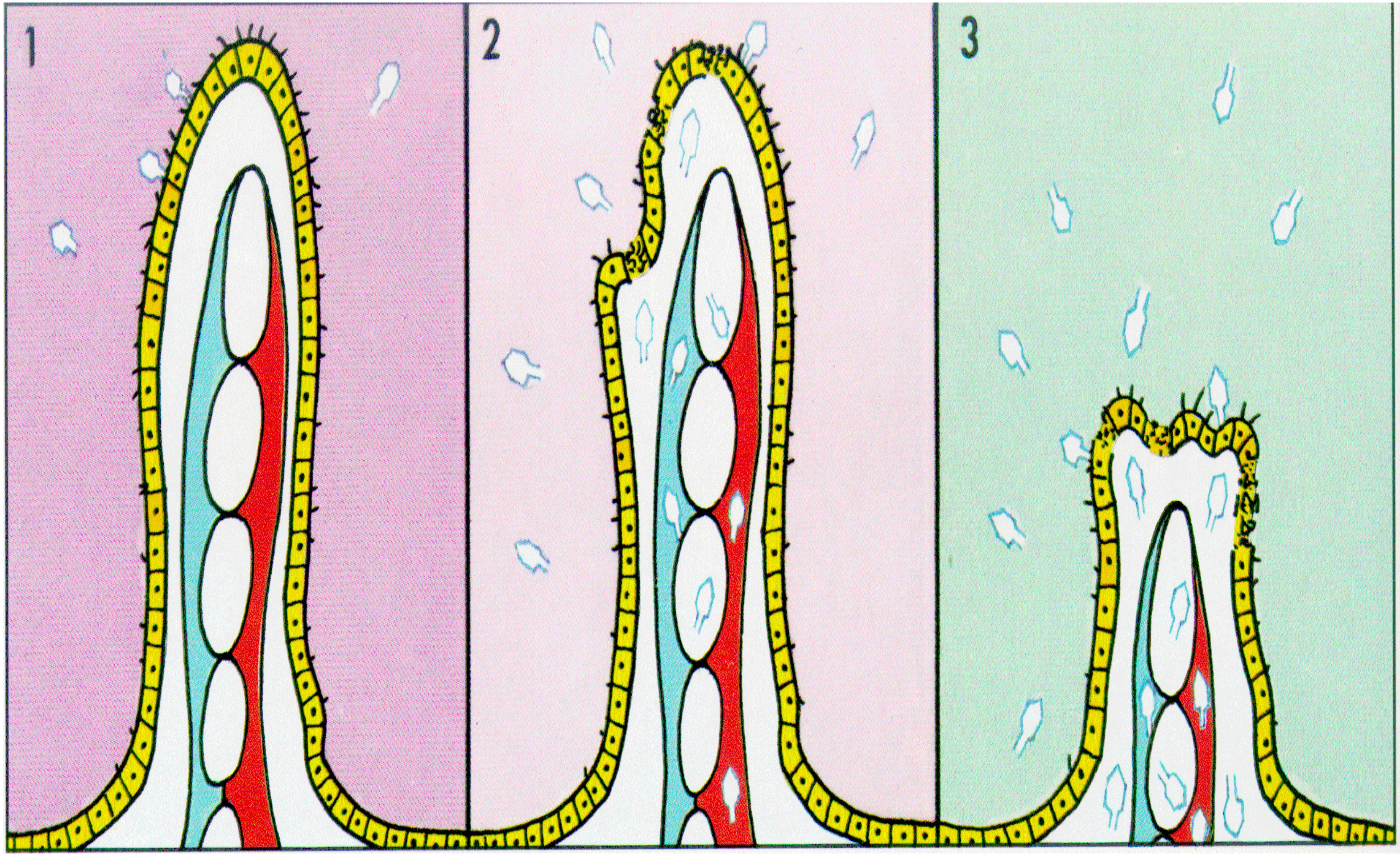
Overview of Pathogenesis

- Pathogenesis of diarrhea is one of, or a combination of:
  - Toxin production: fluids leak into gut
  - Damage intestine epithelium: malabsorption of nutrients
  - Inflammatory response: edema, cell damage
  - Osmotic effect: Fluids drawn into lumen

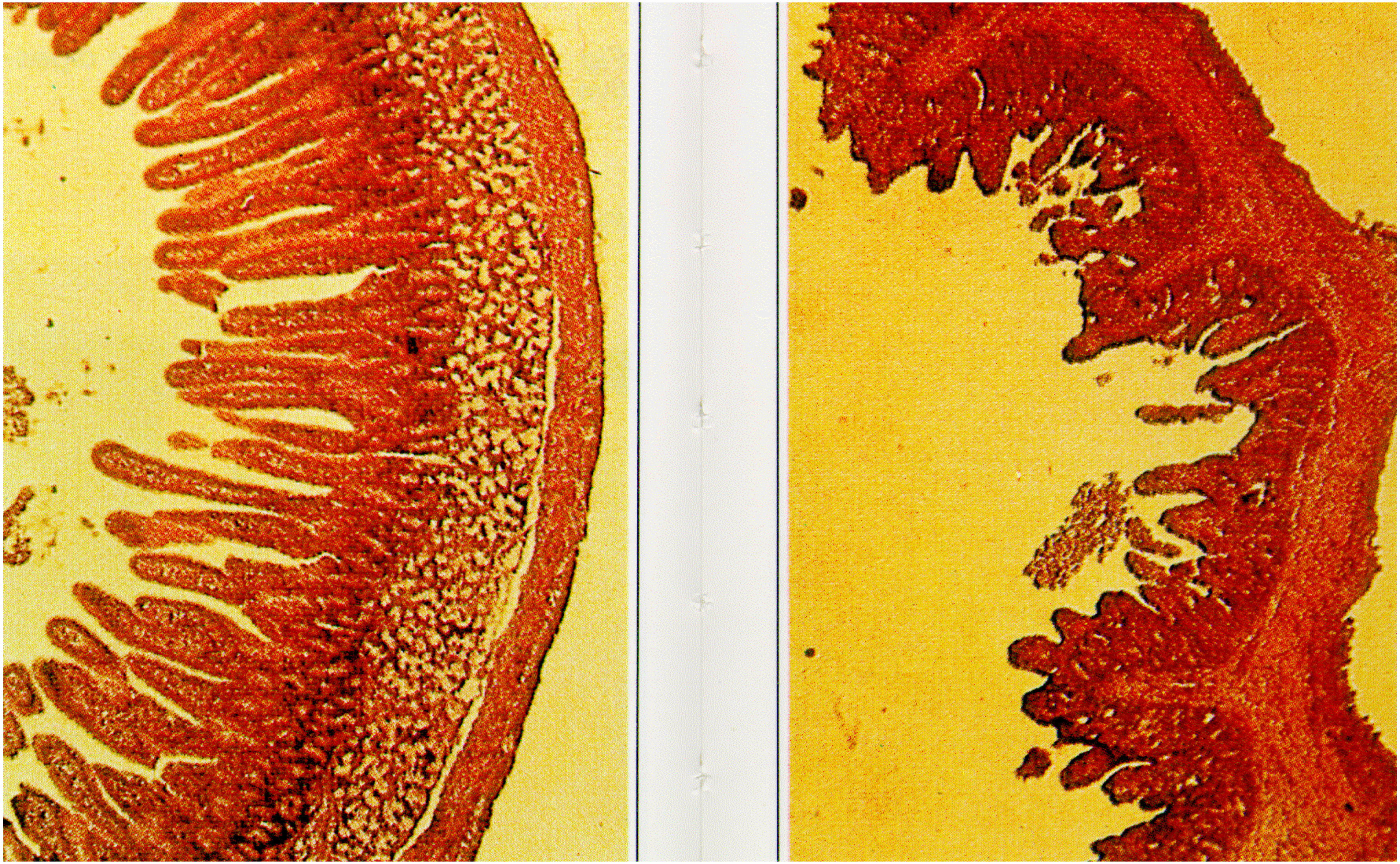




Damage of Intestinal Villi



Damage of Intestinal Villi



Calf Scours - Pathogenesis

- Enterotoxin (Exotoxin) –
  - Increased intestinal secretion
  - *E. coli* K99
  - Salmonella
- Disruption of absorptive villus
  - Rotavirus
  - Coronavirus
  - Cryptosporidia

- Inflammatory response
  - Salmonella
  - Clostridium
- Osmotic effect
  - Nutritional
  - Secondary to malabsorption

Calf Scours – Pathogenic Sequellae

- Dehydration
- Metabolic Acidosis:
  - loss of bicarbonate & electrolytes (sodium, chloride, potassium) from ECF
- Hypokalemia (intracellular)
- Endotoxemia
- Sepsis
- Hypothermia

Detection, Diagnosis and Treatment of Scours

Detection of Sick Calves

- Early detection and aggressive treatment is a MUST for good success!

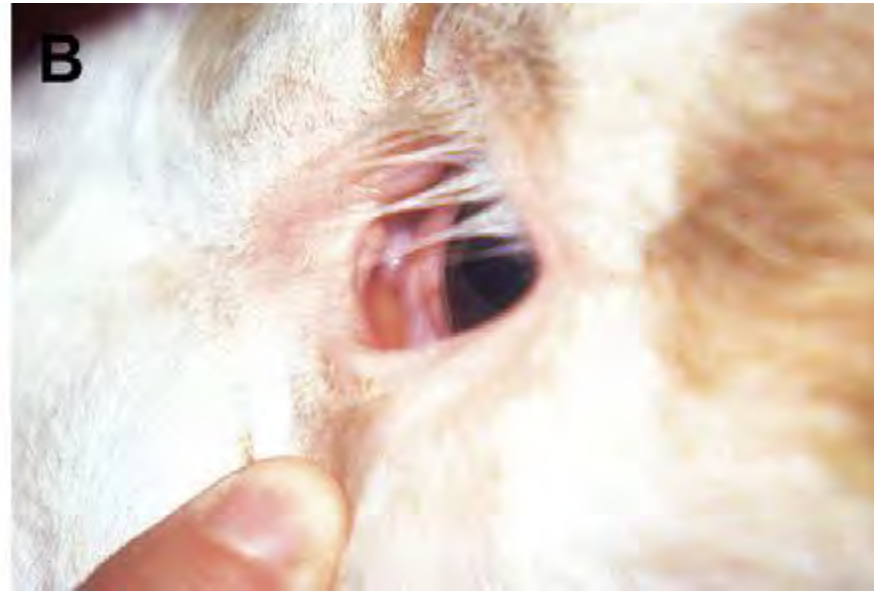
- Clinical signs:
  - Depression, inappetence
  - Weak suckle reflex
  - Scours
  - Weak or unwilling to stand
  - Sunken eyes
  - Increased rectal temperature (> 103^{o}F) (note: may be subnormal if advanced)
  - Pale, dry mucous membranes
  - Cool extremities

Fecal Scores

- Normal fecal scores = 0
- Scours = 1

FECAL SCORE			
Normal	Semi-formed, pasty	Loose	Watery
			
0	**0**	**1**	**1**

Assessing Dehydration in Scouring Calves



- Calf (A) has a normal hydration status. There is no space between the eyelid and the eyeball.
- Calf (B) is severely dehydrated. The eye is sunken at least 7 to 8 mm into the orbit.

Images from G. Smith. Vet Clinics of North America. Food Animal Practice. 2009. 25(1): Pg. 56

Guidelines for Assessing Dehydration of Calves

Dehydration	Demeanor	Eyeball Recession	Skin Tent Duration (s)
< 5%	Normal	None	< 1
6% - 8% (mild)	Slightly depressed	2-4 mm	1-2
8% - 10% (moderate)	Depressed	4-6 mm	2-5
10%-12% (severe)	Comatose	6-8 mm	5-10
> 12%	Comatose/dead	8-12 mm	>10

from G. Smith. Vet Clinics of North America. Food Animal Practice. 2009. 25(1): pg. 57

Calf Scours – Establishing a Diagnosis

- Clinical cases
  - Feces – chilled (or frozen) from several affected animals
  - Culture: *E. coli* (FA+ve K99), Salmonella, C. jejuni
  - EM – rotavirus/coronavirus
  - DFA – rotavirus/coronavirus
  - ELISA – rotavirus
  - Fecal flotation – coccidia
  - Fecal flotation plus staining – cryptosporidia
  - Direct smear and staining – cryptosporidia
- Postmortem
  - Tied off loop of gut for fecal analysis – fresh chilled or frozen
  - Tied off loop placed in formalin for histopath
  - Fresh gut for FA staining of frozen sections
- Note: advanced autolysis hinders/prevents diagnosis

Calf Scours – Principles of Treatment

- Fluid therapy:
  - Correct dehydration, correct metabolic disturbances
  - Oral or Intravenous
- Antibiotic Therapy?
  - Not warranted for viral or parasitic infections
  - Based on fecal culture and sensitivity anlaysis
  - Treat bacterial causes (*E. coli*, Salmonella)
  - Prevent secondary sepsis
  - Prevent concurrent diseases
- Non-steroidal anti-inflammatories (e.g. meloxicam, banamine)
  - Useful to relieve pain and keep the calf eating
- Other? Pepto Bismol, Kaopectate, Mucopolysaccharides

Fluid therapy for scouring calves

- Begin fluid/electrolyte therapy at first signs of scours.
- Offer fluids between milk meals.

- How to give fluids:
  - Oral by bottle:
    - if mild dehydration but still strong suckle reflex.
  - Oral by Esophageal tube feeder
    - if moderate dehydration, still standing, but weak suckle reflex.
  - IV fluids:
    - if severe dehydration (recumbent)

Goals for Oral Electrolytes

- Correct dehydration
- Correct acidosis
- Provide:
  - Amino acids
  - Electrolytes (e.g. sodium)
  - Energy source: Glucose or Glycine
  - Alkalinizing agent: Acetate, Bicarbonate or Citrate
- Avoid:
  - High sodium: Sodium toxicity
  - High osmolality: worsens diarrhea / can cause bloat

Oral Electrolyte Solution Examples

(From G. Smith. TechMix bulletin. 03/2015)

	Sodium (mM/L)	Amino Acid	Osmolality (mOsm/L)	Alkalinizing Agent (mM/L)	Comments
Dr. Smith's Recommendation	**90-130**	**Glycine**	**400-600**	**Acetate (50-80)**	
Blue Ribbon	144	Glycine	390	None	Not good – No alkalinizing agent
Diaque	90	Glycine	377	Bicarbonate (25 mM/L) & Acetate (12 mM/L)	Good
Enterolyte HE	105	Glycine	739	Bicarbonate (80 mM/L)	Osmolality too high – worsens diarrhea/bloat
Bluelite Replenish	123	Glycine	425	Acetate (59 mM/L) & Sodium Propionate (21 mM/L)	Very good

Do we keep feeding milk to a scouring calf?

- YES. Do NOT stop feeding milk:
  - Fluid/electrolyte products do NOT provide adequate energy for maintenance requirements.
  - To avoid starvation, continue to feed milk or milk replacer.
- Do not mix milk and electrolytes together:
  - Fluid/electrolyte products may prevent normal clotting of milk in the abomasum
  - Feed milk approx. 2 hrs before or after electrolytes.
- Decrease volume milk per feeding (e.g. 1 qt./meal) but increase frequency (e.g. 4 meals/day).

IV fluid replacement calculations

- To replace fluid deficit in dehydrated calves:
  - Body wt (in kg) x % dehydration = L of replacement fluid needed

e.g. 100 lb calf = 45 kg

If 10% dehydrated – calf needs 4.5 L of replacement fluids

Fluid Replacement Therapy

Degree of Dehydration (%)	Maintenance water needs (L/d) [1]	Fluid water requirement (L/d)	Total Fluid therapy required (L/d)	(qt/d)
2 %	4.0	1.0	5.0	4.7
4 %	4.0	1.8	5.8	5.5
6 %	4.0	2.7	6.7	6.3
8 %	4.0	3.6	7.6	7.2
10 %	4.0	4.5	8.5	8.0

Calculated for 45 kg calf

[1] Maintenance water estimated at 4.0 L/d (McGuirk, 1992)

Adapted from Davis and Drackley, 1998

Goals for Intravenous Fluids

- Correct dehydration
- Correct acidosis
- Correct hypoglycemia
- Correct hypothermia (warm fluids)
- No additional K+ should be added (calves often hyperkalemic)
- Start with isotonic bicarbonate
- Can use saline with added bicarbonate
- Can add 50% dextrose to create 2.5 – 5% final solution

Examples of fluids commonly used in intravenous therapy

	Na^+	K^+	Ca^{++}	Mg^{++}	Cl^-	Alkalinizing Agent	Energy Source
0.9% Saline *	155				155		
1.3% Sodium Bicarbonate *	156					$HC0_3^-$ 156	
Lactated Ringer Solution	130	4	3		107	Lactate$^-$ 30	
Normosol R	140	5		3	98	Acetate$^-$ 25	Gluconate$^-$ 25
Plasmalyte 148	140	5		3	98	Acetate$^-$ 27	Gluconate$^-$ 23
5% Dextrose **							Glucose 278

* Mixtures of saline & 1.3% sodium bicarbonate and saline are often used.
- Can also mix 13 g sodium bicarbonate (baking soda) in 1 L water.

** IV fluids often spiked with 50% dextrose to give final concentration of 5% dextrose if hypoglycemia is suspected.

Table Adapted from: Large Animal Internal Medicine, 5th Ed., Bradford P. Smith, 2015. Mosby-Year Book Inc., St. Louis MO. Pp. 330 (Table 20-11)

4 types of intravenous solutions to consider

- 1.3% Isotonic sodium bicarbonate solution (first choice)
  - For calves with dehydration and acidosis
  - 13 g $NaHC0_3$/L water
  - or add 150 ml vial of 8.4% $NaHC0_3$ solution to 1 L sterile water
  - Dextrose can be added to achieve 5% final solution

- Acetated or Lactated Ringer's solution (second choice):
  - Calves with mild or moderate acidosis
  - Don't give unless confirm NOT hyperkalemic (contains K+)

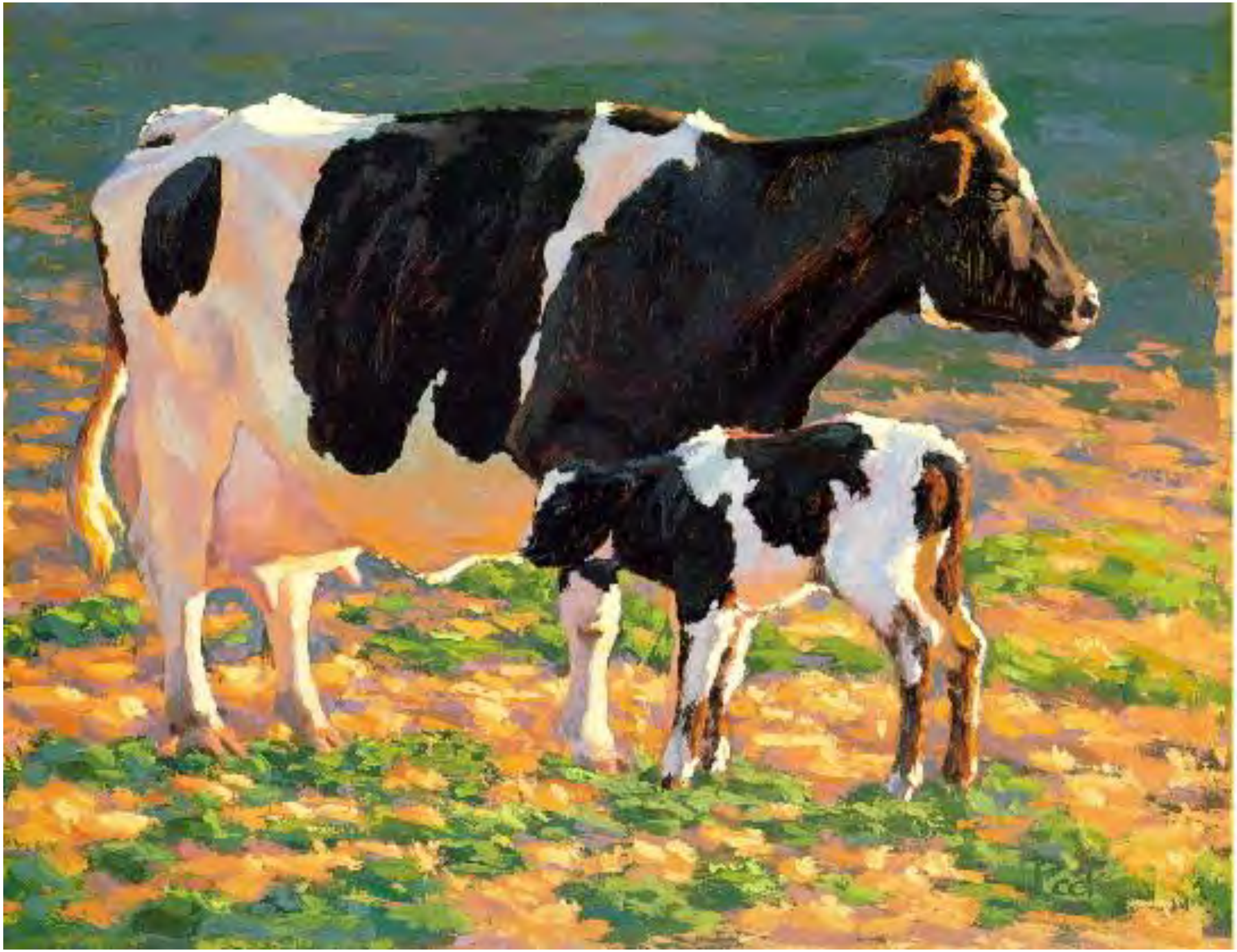
- Hypertonic saline:
  - 4-5 ml/kg I.V. (175 - 200 ml for 43 kg/100 lb calf)
  - MUST give with oral fluids
  - Will rehydrate, but won't correct metabolic acidosis

Antibiotics and Anti-inflammatories: Principles of drug selection?

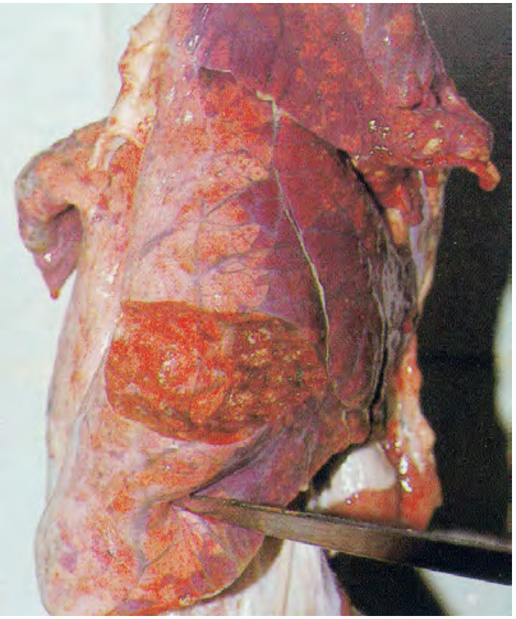
- Consider the organism:
  - Will they respond to antibiotics (bacteria, viruses, parasites)?
- Consider the severity:
  - Most mild and moderate scours cases do not require antibiotics
- Do no harm:
  - Avoid pain and toxicity
  - E.g. aminoglycocides, tetracyclines, flunixin are nephrotoxic
  - Only give flunixin after rehydration
- AMDUCA – Use label drugs if available:
  - Many drugs labeled for pneumonia
  - None labeled for septicemia or Salmonella

Diagnosis and Treatment Protocols

- Producers should work with herd veterinarian to develop protocols for:
  - Daily monitoring of calves for early detection of disease
  - Aid in making a preliminary diagnosis
  - Guide in responsible treatment protocols (including selection of products, doses, routes, duration, and withdrawal times)
  - Training of farm staff to implement all of above

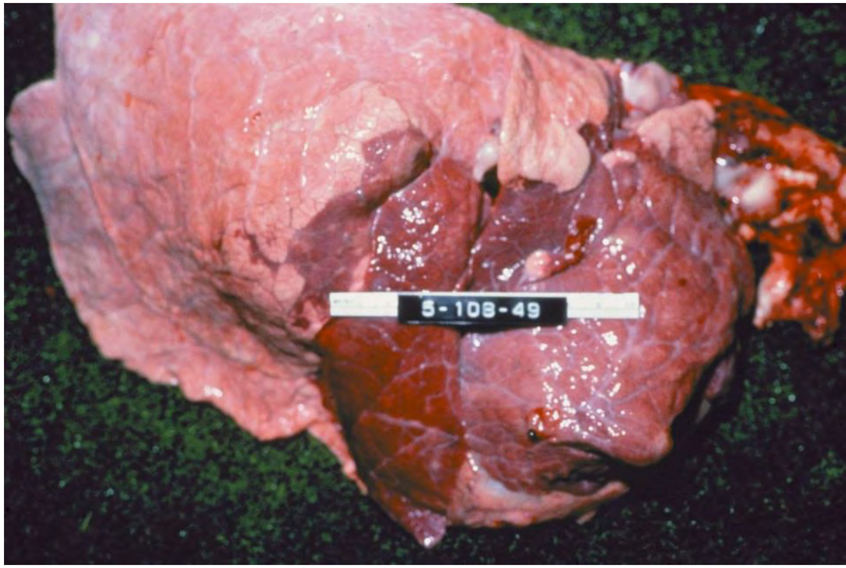


Pneumonia



- The 2nd most common disease in calves between 1- 6 mos old.

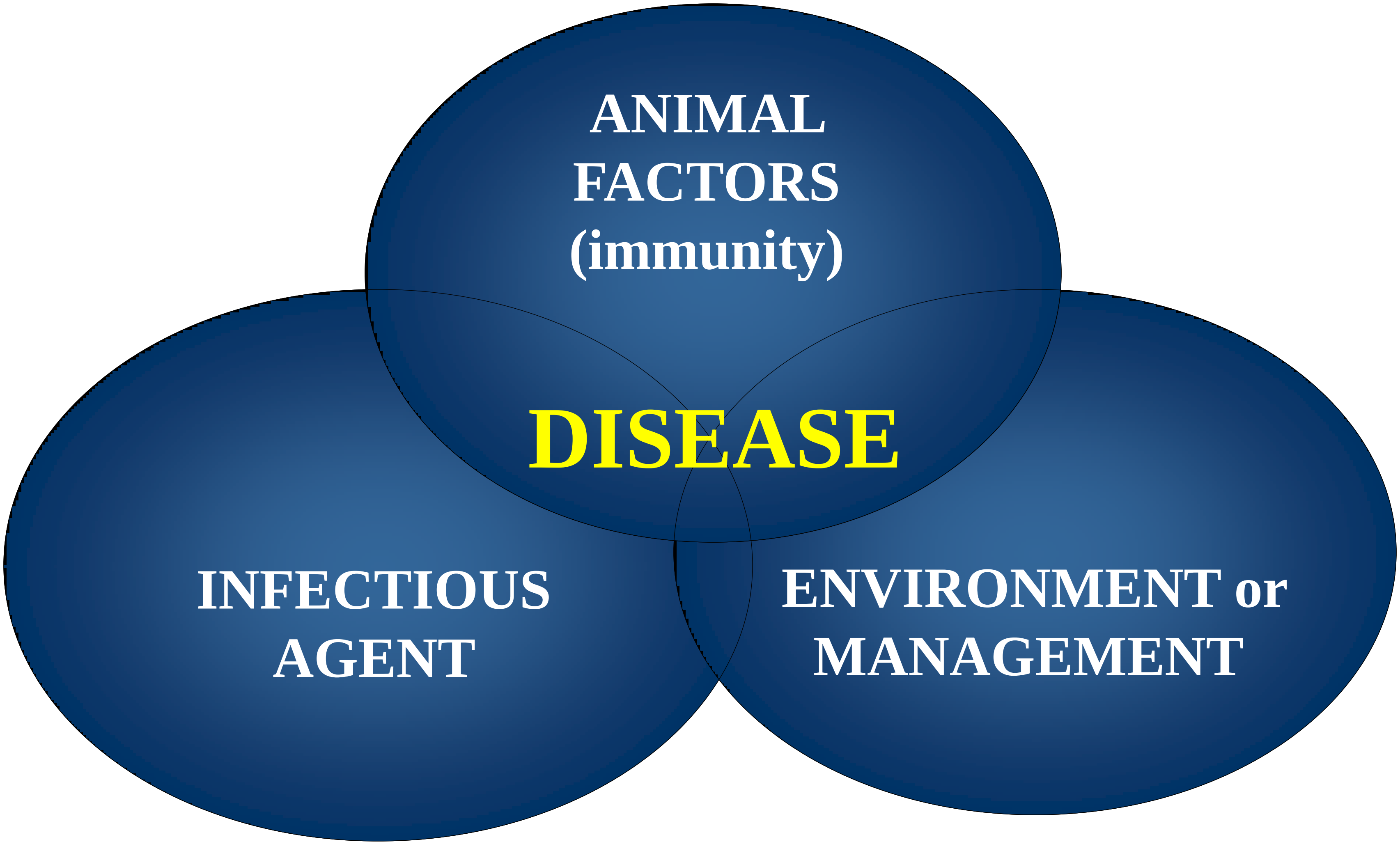
- Enzootic Calf Pneumonia:
  - “continuously in the herd’
  - Can occur as outbreaks or as chronic low-level disease



Consequences of Enzootic Calf Pneumonia

- Calves with pneumonia at 1-3 mos. old have:
  - Decreased growth rates
  - 2.5 times more likely to be culled prior to calving
  - 4.5 to 6 mos. older at first calving
  - Increased risk for culling in first lactation

Multifactorial Disease



Pneumonia – Infectious Agents

- Bacterial agents
  - Pasteurella multocida
  - Mannheimia hemolytica
  - Trueperella (Arcanobacter) pyogenes
  - Mycoplasma dispar
  - Hemophillus somnus

- Viral agents:
  - IBR (infectious bovine rhinopneumonitis)
  - PI3 (parainfluenza virus)
  - BRSV (bovine respiratory syncitial virus
  - BVD (bovine viral diarrhea virus)

Calf Respiratory Tract Defenses

- Cilia (fine hairs)
- Mucous
- Cellular defenses (neutrophils, macrophages, etc.):
  - Mucous captures viruses and bacteria before can get deep into the lung.
  - Cilia sweep trapped particles up and out of respiratory tract
  - Macrophages engulf & digest foreign particles

Calf Respiratory Tract Defenses

- Viral agents damage respiratory epithelium, cilia, and change mucous quality:
- Predispose to secondary bacterial infections by:
  - Reduced muco-ciliary clearance of bacteria / viruses
  - Decreased macrophage function in lungs => reduced bacterial clearance

Pneumonia – Environmental Factors

- Air temperature: heat or cold stress
- Humidity: > 75% humidity => increased pathogen survival
- Air flow: intake and exhaust:
  - Build-up of noxious gases and pathogens
  - Air flow direction: carry pathogens from young-to-old
- Stocking density: increased pathogen concentration and exposure to young calves.
- Noxious gas level: damages lining of respiratory tract => poor defense mechanisms.

Symptoms of Pneumonia

- Fever > 103 °F (> 39.5 °C)
- Coughing
- Increased respiratory rate or effort, extended or lowered head
- ↑ lung sounds
- Snotty nose, runny eyes
- Dull / depressed
- Separation from group
- Decreased appetite

Treatment

- Consult with herd veterinarian:
  - Antibiotics:
    - dose
    - duration
    - withdrawal time
  - +/- Anti-inflammatories:
    - reduce inflammation in lungs.

DISEASE DIAGNOSIS TREATMENT and MONITORING

- Protocols for:
  - Daily observation to find sick calves early
  - Physical exam to diagnose problem
  - Treatment
- Enlist herd veterinarian to assist:
  - Develop protocols
  - Train staff
- Keep and monitor records:
  - Treatment rate (< 25%)
  - Death loss (< 5%)

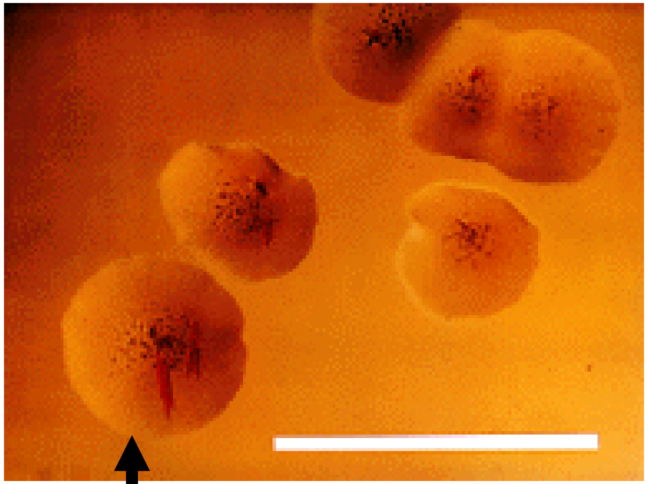
Mycoplsma

- Ex.: *Mycoplasma bovis, M. bovirhinis, M. dispar*

- 3 common disease manifestations:
  - Mastitis in lactating dairy cows
  - Pneumonia and arthritis in feedlot cattle
  - **Pneumonia, arthritis and ear infections (otitis media) in pre-weaned dairy calves**

Mycoplasma, the organism

- Intracellular
- Lacks cell wall
- Susceptible to disinfectants and desiccation
- Facultative anaerobes
- Does not replicate in the environment
- Most are host specific

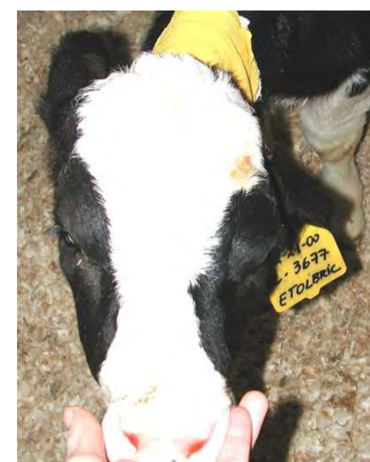


"Fried-egg" appearance

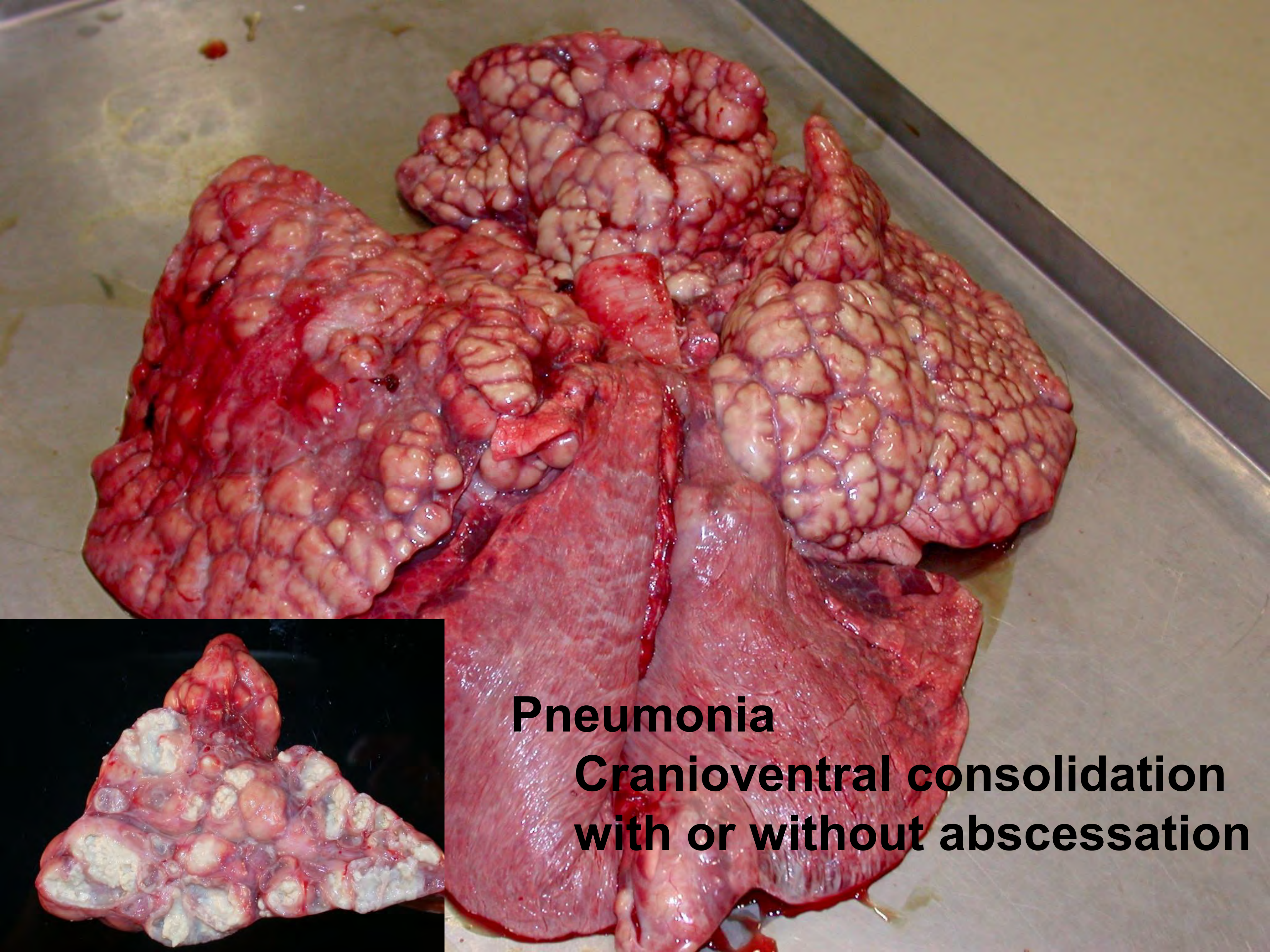
Clinical Signs

- Common in 1 to 8 week old calves

- Clinical signs:
  - 1 or both ears dropped
  - Head tilt, Head and neck extended
  - Eyelid droop
  - Slobbering
  - Ear discharge +/-
  - Non-specific signs: ↓ appetite, depression
  - Signs aren't present early
  - Arthritis / tenosynovitis
  - **Almost always have concurrent respiratory disease**



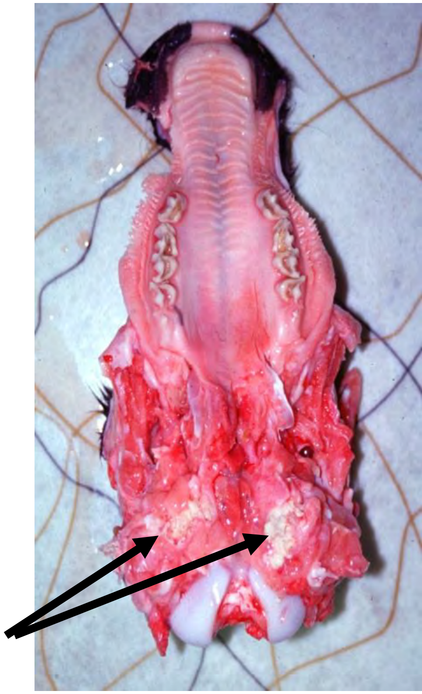
- Not all 'droopy ears' are Mycoplasma
  - *P. multocida, M. haemolytica, A. pyogenes*

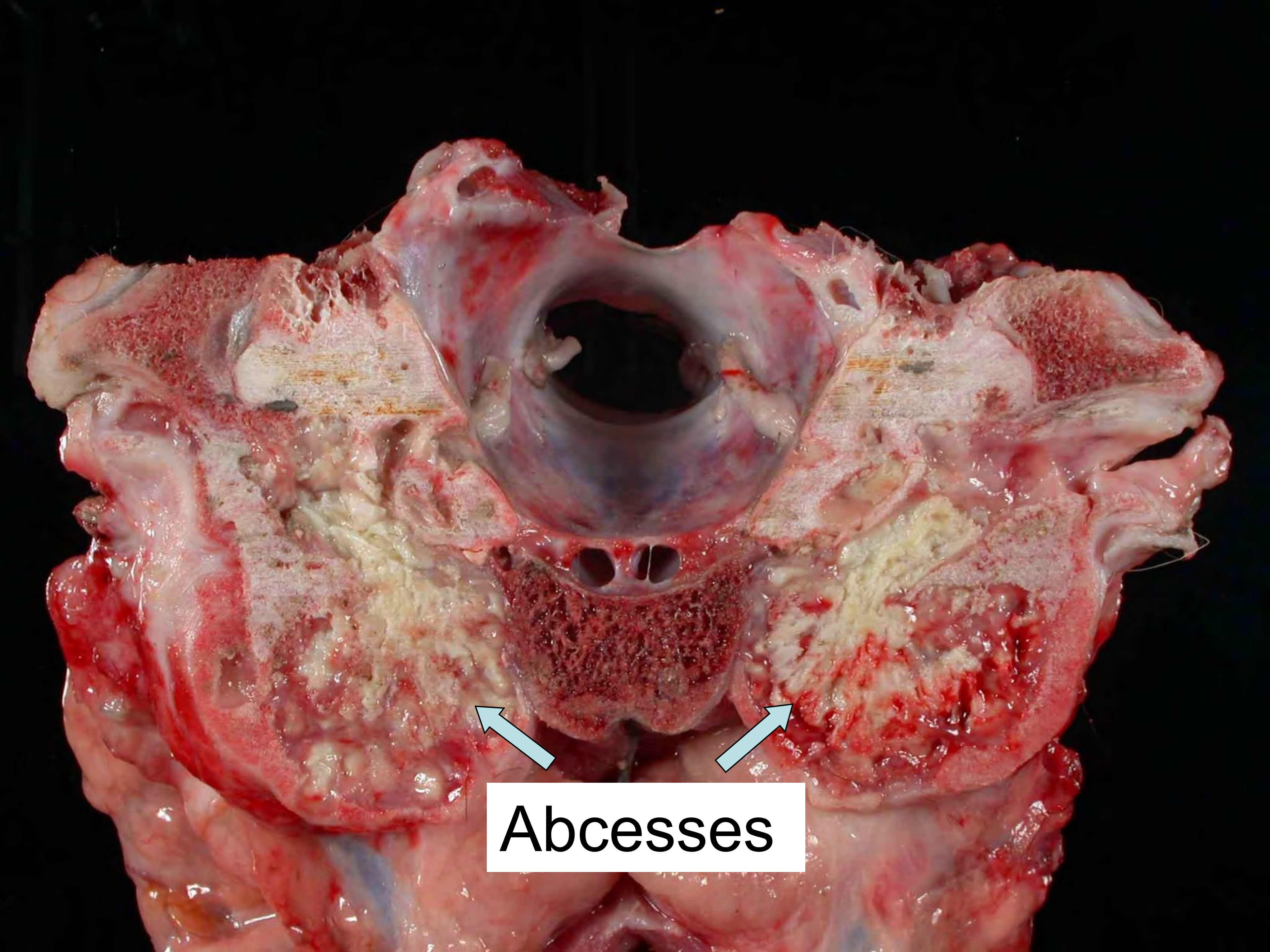

Pneumonia
Cranioventral consolidation
with or without abscessation


Head tilt

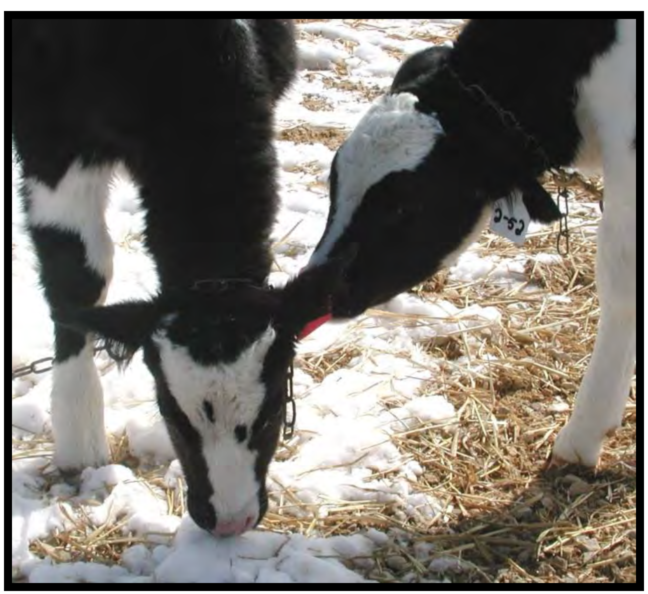
Ear Infections in Calves

- Organisms access middle ear (otitis media):
  - Up the Eustachian tube
  - Entering from the external ear
  - Hematogenous spread (in blood)
- Swelling puts pressure on the nerves
  - Drooping eyelid
  - Head tilt
- Infection may move into the inner ear
- Infection forms abscesses that are difficult to reach and penetrate with treatment




Abcesses

Methods of Transmission



- Ingestion of infective milk or colostrum
- Pathogens shed in respiratory secretions of infected calves:
  - Direct nose-to-nose contact
  - Inhalation of aerosolized organisms

Risk Factors for Mycoplasma Infection

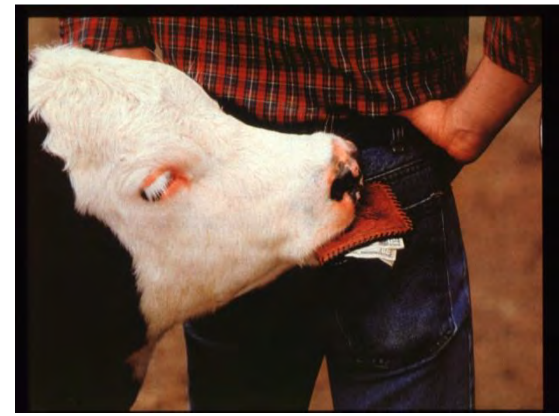
- Calves with failure of passive transfer (FPT)
- Warm, crowded, damp +/or poorly ventilated barns
- Nose to nose contact
- Exposure to infected calves
- Commingled chronic pneumonia calves
- Power washing with contact calves

Treatment of Mycoplasma Infections in Calves

- Early identification and intervention
- Use an effective antibiotic:
  - NOT penicillin, amoxicillin, ampicillin, ceftiofur
  - Potentially useful: Tulathromycin (Draxxin) florfenicol (Nuflor), tilmicosin (Mycotil), spectinomycin, enrofloxacin (Baytril), tetracycline
  - Some strains very resistant
  - Oral antibiotics and/or ear drum puncture: require evaluation

- Adequate treatment duration:
  - 10-14 days
  - Inflammation/tissue damage persist
  - Aspirin may help reduce pain & swelling

Treatment of Mycoplasma Infections in Calves



- Early identification and intervention
- Low cure rate (< 20%)
- Use an effective antibiotic:
  - NOT penicillin, amoxicillin, ampicillin, ceftiofur
  - tetracycline, florfenicol, tilmicosin, spectinomycin potentially useful
  - Some strains very resistant
  - Oral antibiotics and/or ear drum puncture: require evaluation
- Adequate treatment duration:
  - 10-14 days
  - Inflammation/tissue damage persist
  - NSAID may help reduce pain & swelling

The Question of *Mycoplasma* Carriers or Reservoirs…

- Carrier Animals:
  - Immunity to *M. bovis* can develop
  - Organisms can be in the upper respiratory tract without disease
  - Strain may stay in the group for several months
  - Stress can trigger sporadic cases

- Survival in the Environment
  - Liquid 6 months any temp
  - 4 months in warm, dry
  - 1 month in cold, dry

Mycoplasma: Prevention Rather than Treatment

DairyTech batch pasteurizer

- Colostrum Management:
  - 1 healthy cow to 1 calf,
  - pasteurized colostrum (60 °C x 60 min)
  - Colostrum replacers
- Feed pasteurized milk or commercial milk replacer
- Clean, disinfect and dry feeding equipment between uses and between calves


Improperly stored bottles: can’t drain/dry

Mycoplasma: Prevention Rather than Treatment

- ↓ Aerosol contamination
  - Animal density/building volume
  - Dampness
  - VENTILATION!!!

- All in/All out strategies
- Isolation of age groups
- Isolate sick calves and get rid of chronics
- Reduce calf to calf contact

Mycoplasma Vaccination?

- Commercial products are available
  - e.g. Pulmo-guard MpB (Boehringer Ingelheim, Inc.)
    > 45 days of age (Stocker/feedlot)
  - No label for very young calves
  - No claims for ear infections
  - Little evidence of efficacy
  - May be harmful to young calves

- Autogenous bacterins used commonly
  - Little evidence for sustained efficacy
  - Organisms constantly change to avoid the immune system (changing lipoprotein antigens on cell surface)

Mycoplasma in Calves - Summary

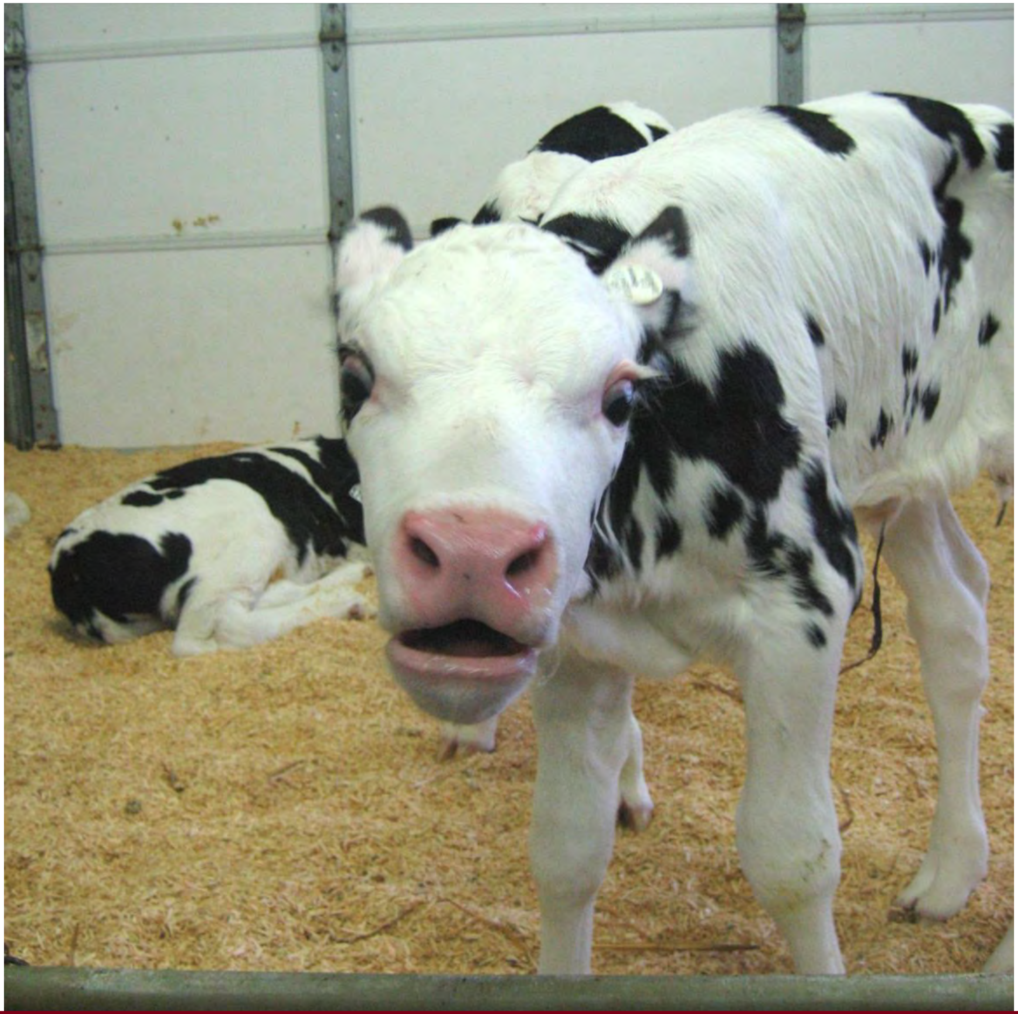
- Middle ear infections almost always accompanied by bovine respiratory disease complex (*P. multocida, M. haemolytica*, etc.)
- Therefore, target risk factors to fix respiratory disease problem before chasing otitis media:
  - VENTILATION!!!
  - All in – all out systems
  - Preventing direct contact between calves
  - Colostrum management
  - Feed pasteurized milk or milk replacer
- Vaccines (commercial or autogenous) are lacking studies to demonstrate efficacy
- Very early detection necessary for treatment success

Summary

- Early detection is critical to good treatment success
- Daily screening – detect, diagnose and treat sick calves
- Causes, diagnosis and treatment of specific diseases
  - Scours
  - Pneumonia
  - Mycoplasma
  - Salmonellosis

College of Veterinary Medicine
University of Minnesota

Thank you!



Please address questions to Dr. Godden: godde002@umn.edu

Goals for Raising Healthy Calves - *Your Future Herd Profit Center*

Sandra Godden DVM, DVSc
College of Veterinary Medicine
University of Minnesota

Goals for the Replacement Heifer Rearing Program

- Goal: In an efficient and economical manner, produce a quality replacement heifer that has the genetics, size, health & immune function, body condition and management background to…

- Breed at 13-15 months of age

- Calve at 22-24 months of age

- Freshen with minimal metabolic and reproductive disorders

- Reach her potential for high 1st lactation milk yield

- Yield the producer higher profits

Why 22-24 Months as a Target Age at First Calving?

Photo from Bob James

Optimal Age at First Calving

(Gill and Allaire. JDSci. 1976. 59:1131)

- Lifetime records from 933 Holstein cows from 8 OH herds
- Profit function defined from milk production, body weight, repro. performance, herdlife, and prices for feed energy, milk, calves, salvage value, and fixed costs.
- Optimum total lifetime performance if
  22.5 - 23.5 mos at first calving

22.5 - 23.5 mos

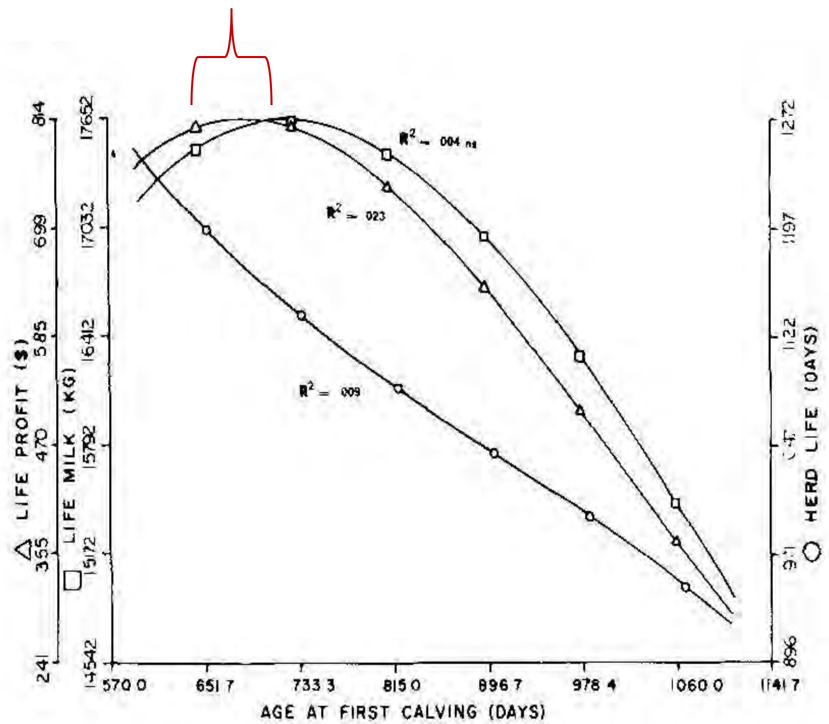
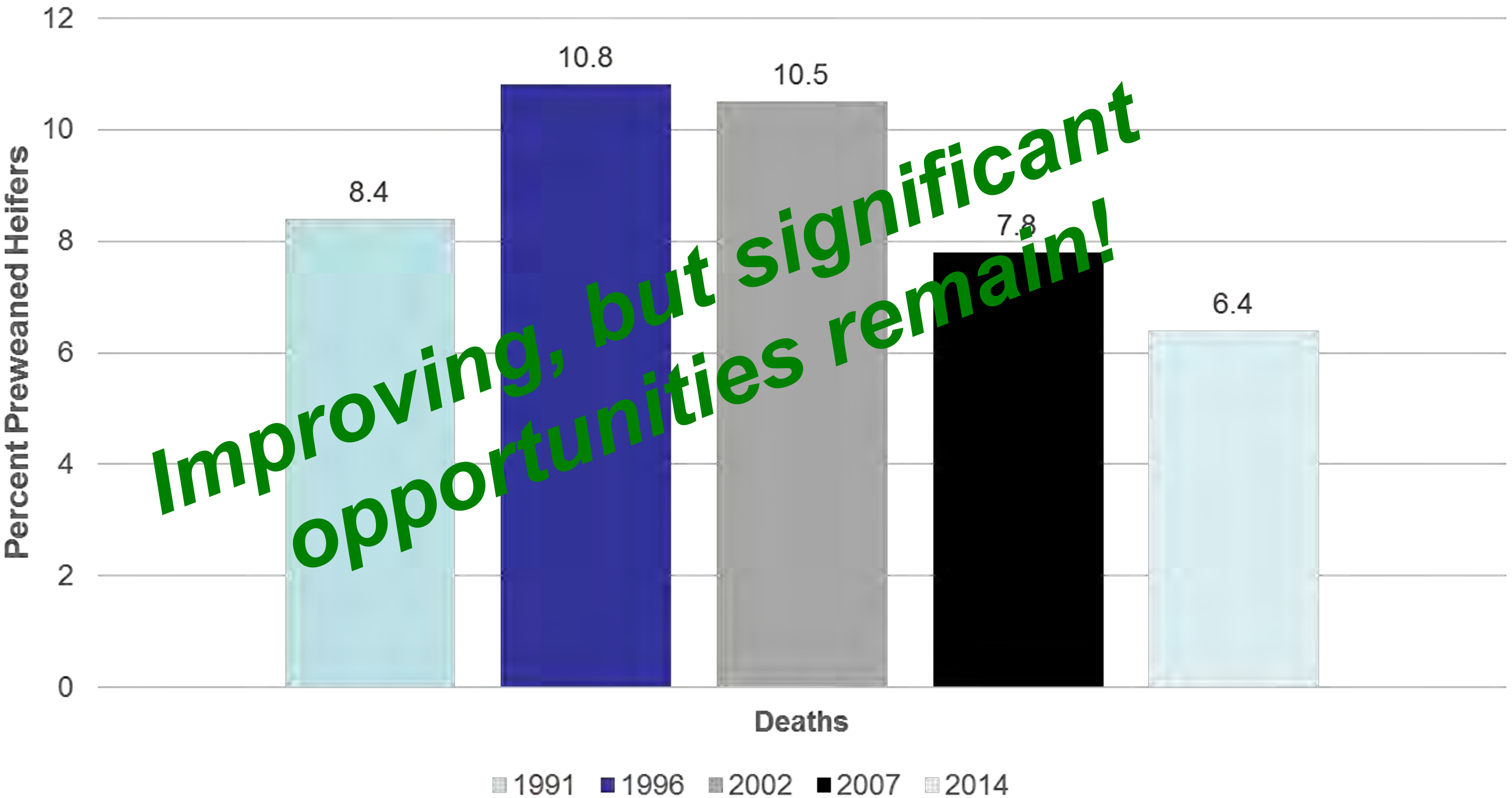


FIG. 1. Polynomial regression curve (3°) of total lifetime traits on age at first calving.

How do we Achieve this Goal?

- Disease prevention (health/growth)
- Nutritional management (health/growth)
- Reproductive management (breeding at 13-15 months of age)

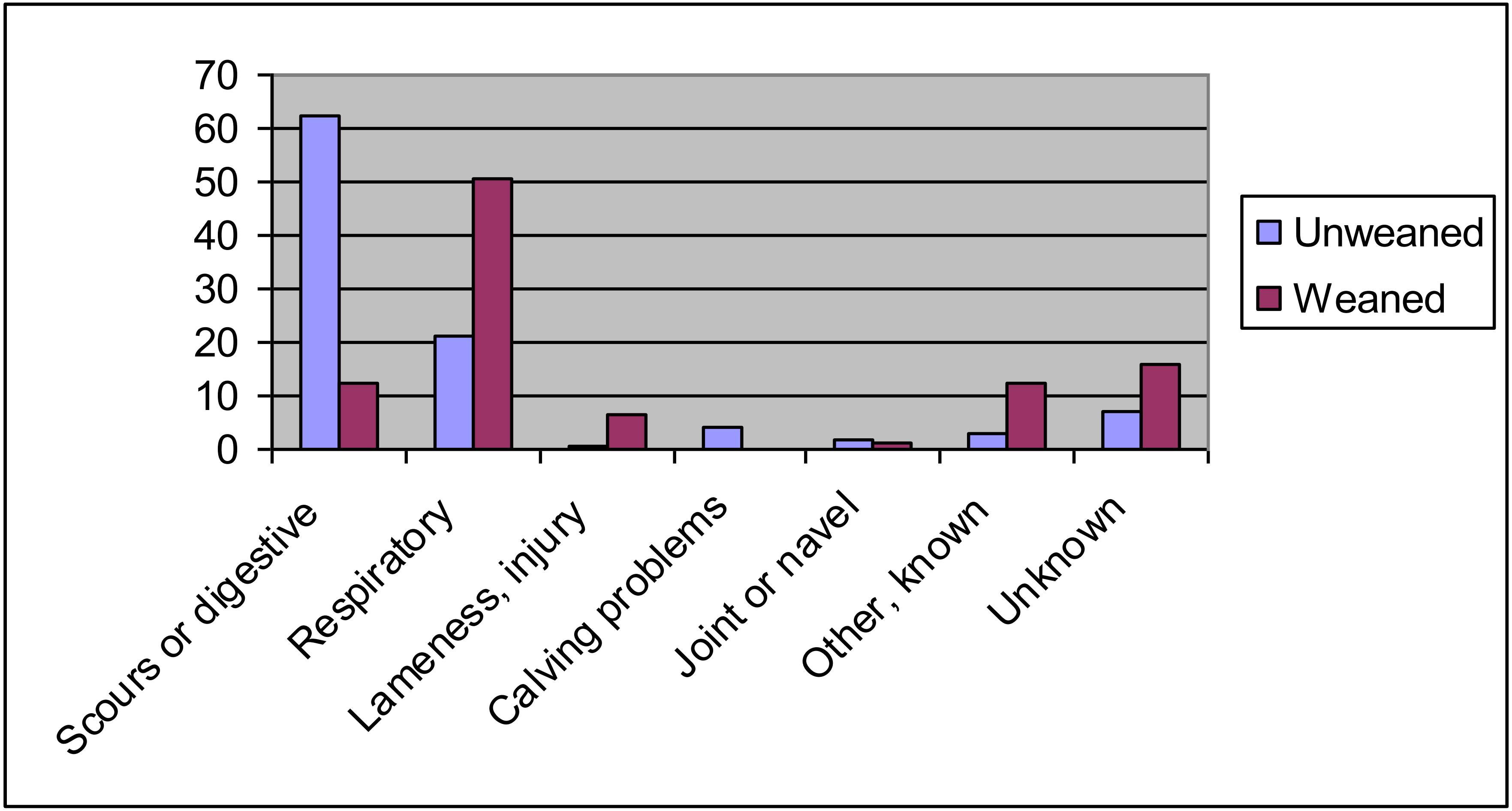
Is the Dairy Industry Succeeding with Calf Health Management?



NAHMS Dairy 2014

Causes of Calfhood Mortality

(NAHMS, 2007)



Impacts of Calfhood Disease

- Short term costs of preweaning disease:
  - Labor, drugs, veterinary fees
  - Mortality (replacement costs, genetic losses)

- Long term costs of preweaning disease:
  - Reduced feed efficiency
  - Impaired growth
  - Prolonged age at first calving
  - Reduced milk production
  - Premature culling/death
  - Reduced lifetime profitability

Impact of Calfhood Disease on Rate of Gain

- Disease events causing depressed gain by 6 mos. of age:
    - Pneumonia event: ↓ 10.6 kg
    - Septicemia event: ↓ 4.8 g
    - Scours event: ↓ 9.1 kg

(Donovan et al., Prev. Vet. Med. 1998. 33:1)

Impact of Calfhood Disease on Longevity

- Effect of disease at < 90 days on death, culling:
  - ‘Dull’ event: 4.3 times increased risk of mortality between 90 to 700 days of age

    (Curtis et al., Prev. Vet. Med. 1989. 7:173)
  - ‘Pneumonia’ event: 2.5 times more likely to die after 90 days of age (90 - 900 days)

    (Waltner-Toews et al., C.J.V.Res. 1986. 50:314
  - ‘Scours’ event: 2.5 times more likely to be sold after 90 days of age (90-900 days)

    (Waltner-Toews et al., C.J.V.Res. 1986. 50:314)

Impact of Calfhood Disease on Age at 1st Calving

- ‘Diarrhea’ event: 2.9 times more likely to calve after 900 days of age

(Waltner-Toews et al., C.J.V.Res. 1986. 50:314)

- ‘Pneumonia’ event: 2 times more likely to calve 6 months later

(Correa et al., Prev. Vet. Med. 1988. 6:253)

- ‘Dullness’ event: 1.6 times more likely to calve 2 months later

(Correa et al., Prev. Vet. Med. 1988. 6:253)

So what are our targets for health and growth?

Parameter	24 hrs – 60 days	61 – 120 days	121 to 180 days
Mortality Rate (%)	< 5%	< 2%	< 1%
Scours Rate (%)	< 25%	< 2%	< 1%
Pneumonia Rate (%)	< 10%	< 15%	< 2%
Growth Rate (lb/day)	Double birth weight (approx. 1.6-1.8 lbs/d) (e.g. born 90 lb => 180 lb at 8 weeks)	2.2 lbs	2.0 lbs

Dairy Calf and Heifer Association Gold Standards
(www.calfandheifer.org)

Targets for Growth as a Percentage of Mature Body Weight (MBW)

- Example: MBW of 3rd lactation cows = 1500 lbs
- Puberty: 50-55% of MBW (e.g. 825 lbs)
- Breeding: 60-65% of MBW (e.g. 975 lbs)
  > 48 inches withers height
- First calving: 85% of MBW (e.g. 1,275 lbs)
- 2nd calving: 92% of MBW
- 3rd calving: 96% of MBW

Target profiles are averages – Need to know what the mature cows weigh in this herd? (Hoffman, 2003)

Summary of youngstock program goals

- Health:
  - Preweaning: morbidity < 25%, mortality < 5%
  - Postweaning: morbidity < 15%, mortality < 3%
- Growth:
  - Preweaning: ADG 1.6-1.8 lbs/day
  - Postweaning: ADG 2.0-2.2 lbs/day
- Life events
  - Breed 13-15 months w > 48 inches at withers
  - First calving at 22-24 months

Key Management Areas for Preweaned Calves

- Late gestation
- Maternity pen management
- Care of newborn calf
- Colostrum management
- Housing and sanitation
- Preweaning nutrition
- Disease detection and treatment
- Pain management

Pros, Cons and Best Management Practices for Group Housing of Pre-weaned Dairy Calves

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– Mike Van Amburgh (Cornell U)
– Hugh Chester-Jones (U of MN)
– Bob James (Virginia Tech)
– Tom Earleywine (LO'L Animal Milk Products)
– Neil Anderson (OMAFRA)

Key Management Areas for Preweaned Calves

- Late gestation
- Maternity pen management
- Care of newborn calf
- Colostrum management
- **Housing and sanitation**
- **Preweaning nutrition**
- **Disease detection and treatment**
- Pain management

Outline

?

Feeding system vs Housing system?

- Review goals and principles for nutrition and housing
- Group housing / computer feeders:
  - Pros and Cons
  - What have we learned?
  - Recommendations for management

Plane of nutrition in preweaned calves affects…

- Calf:
  - Growth
  - Ability to cope with cold stress
  - Immune function / health

- Adult cow:
  - Age at first calving
  - Milk production
  - Longevity
  - Lifetime economics

- Goal: Double birth weight by 56 days of age

  40 kg BWt => 80 kg at weaning

  (ADG = 0.71 kg/day or 1.6 lb/d) (Van Amburgh, AABP, 2009)

Options for milk feeding programs

- The old program (10% BWt):
  - Milk or milk replacer (20:20) at 1-1.25 lb DM/day

- The new program (20+% BWt):
  - Accelerated milk replacer (28:20) at 2-2.5 lb DM/day

    or

  - Whole milk (26:29) at 2-2.5 gallons/day

‘Accelerated’ or ‘Full potential’
= biologically normal growth before puberty

Effects of Neonatal Nutrition on Health and Future Productivity

- Though data are not all conclusive, the majority of studies conclude that early life nutrient intake has:
  - Short term impacts on health, growth
  - Long term impacts on productivity
  - …and therefore economics

Characteristics of an Ideal Calf Housing System

- No contact with older animals or their environment (air, water, bedding, feed, pasture)
- Avoid direct contact between calves
- All in – all out
- Air quality / ventilation
- Bedding: Clean, dry, abundant, comfortable
- Sanitation
- Prevent stress / injury (calves & people)
- Facilitates ease of handling
- Socialization of calves to humans and to each other

Hutches

- Advantages:
  - Can control and monitor milk intake
  - No calf-to-calf contact
  - All in – all out
  - Good air quality (*usually*)
  - Can move to new ground (*but do they?)*
  - Easy to assess appetite, attitude & detect disease
  - Socialized to people

- Potential disadvantages:
  - Operator comfort
  - Labor intensive
  - Socialization to other calves? Can see & hear others, but no direct contact

Individual Pens in Naturally Ventilated or Heated Barns

- Same general advantages and disadvantages as hutches except…
- Advantages over hutches:
  - Improved operator comfort
- Potential disadvantages:
  - May allow direct contact?
  - Ventilation in winter?
  - Pathogen build-up?

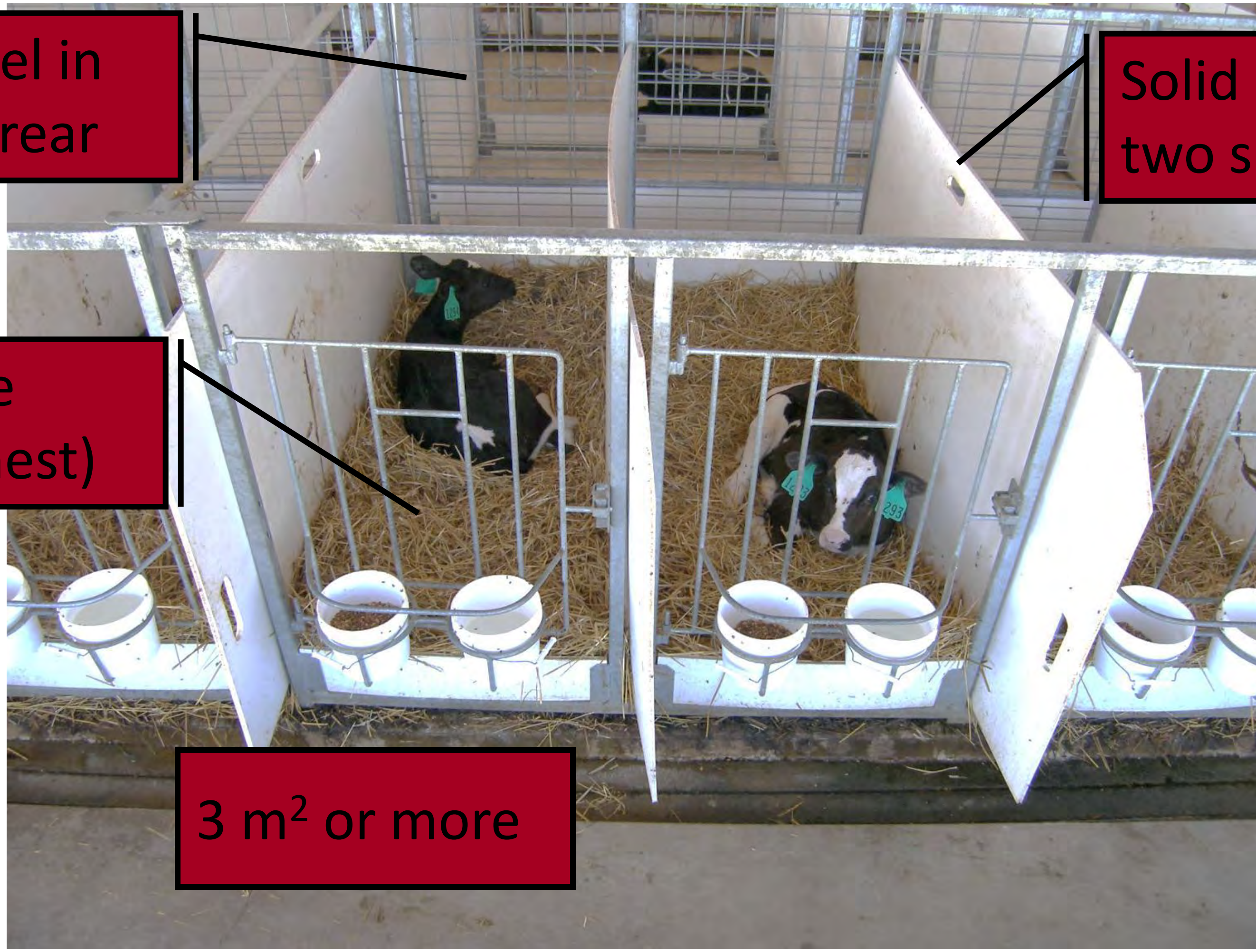
Solid vs Open Partitions - A disease risk factor

(Lago et al., 2006. JDSci. 89:4014)

Solid preferred over open partitions to reduce disease transmission.

Calves should still be able to see and hear other calves.

Factors Associated with Reduced Prevalence of Respiratory Disease in Individual Pens / Cold Barns

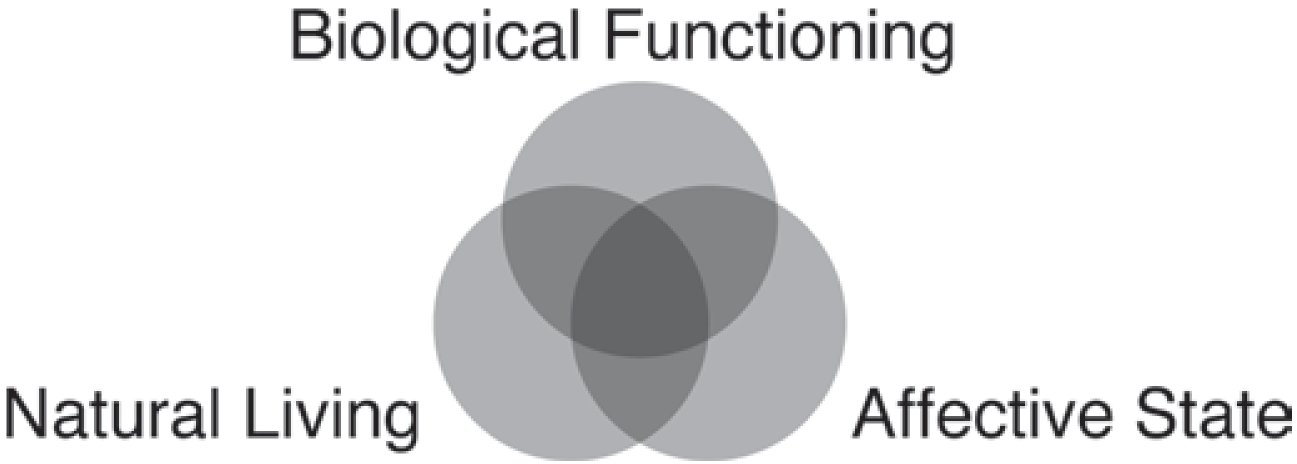


(Lago et al., 2006. JDSci. 89:4014)2

Group Housing Systems

- Potential benefits:
  - Computerized or ad lib feeding facilitates delivery of increased quantities of milk
  - Reallocation of labor
  - Freedom to socialize and exercise
- Disadvantages/Risks:
  - Increased morbidity
  - Potential for competition for feed/space
  - Harder to detect sick calves
  - Calves less socialized to people
  - Increased cross sucking?

What housing system is best for calf welfare?



No system appears to be perfect.

Pair housing – Is this the best compromise?

Is ‘2’ the optimal group size?

Another example of pair housing

Is ‘2’ the optimal group size?

Group-Housed Calves

Photo courtesy of Dr. Neil Anderson. OMAFRA (Ont. Ministry of Ag & Food)

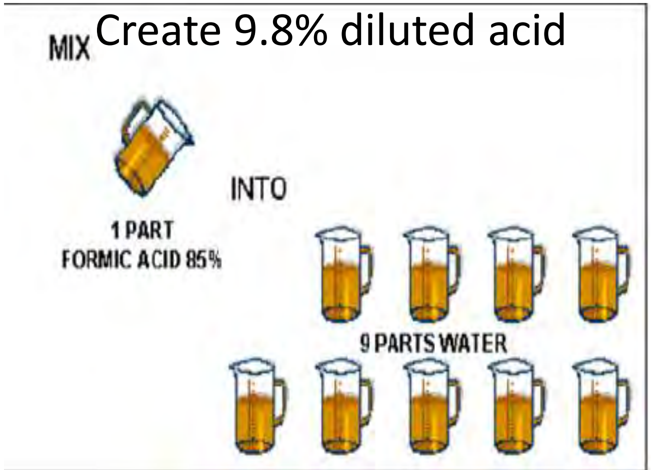
Milk Delivery Systems for Group Housed Calves

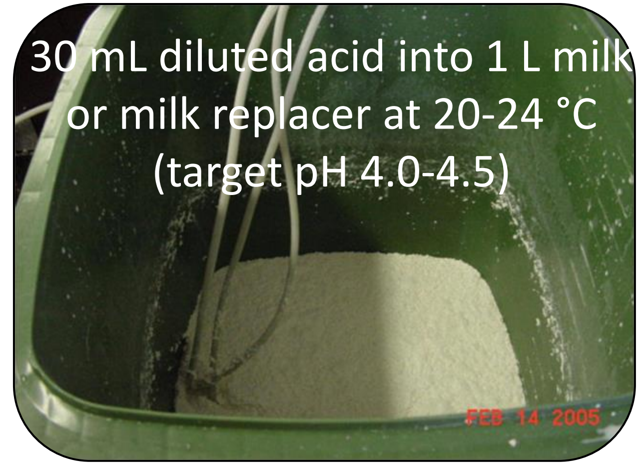
- Mob feeding
- Acidified milk
- Computer feeders

Mob Feeding

- Pro: It’s quick
- Cons:
  - Competition
  - May still be limiting intake (can’t control intake)
  - Cross sucking (esp. if still hungry)

Free choice acidified milk





Photos courtesy of Dr. Neil Anderson. OMAFRA (Ont. Ministry of Ag & Food)

http://www.omafra.gov.on.ca/english/livestock/dairy/facts/mimick.htm

Free choice acidified milk

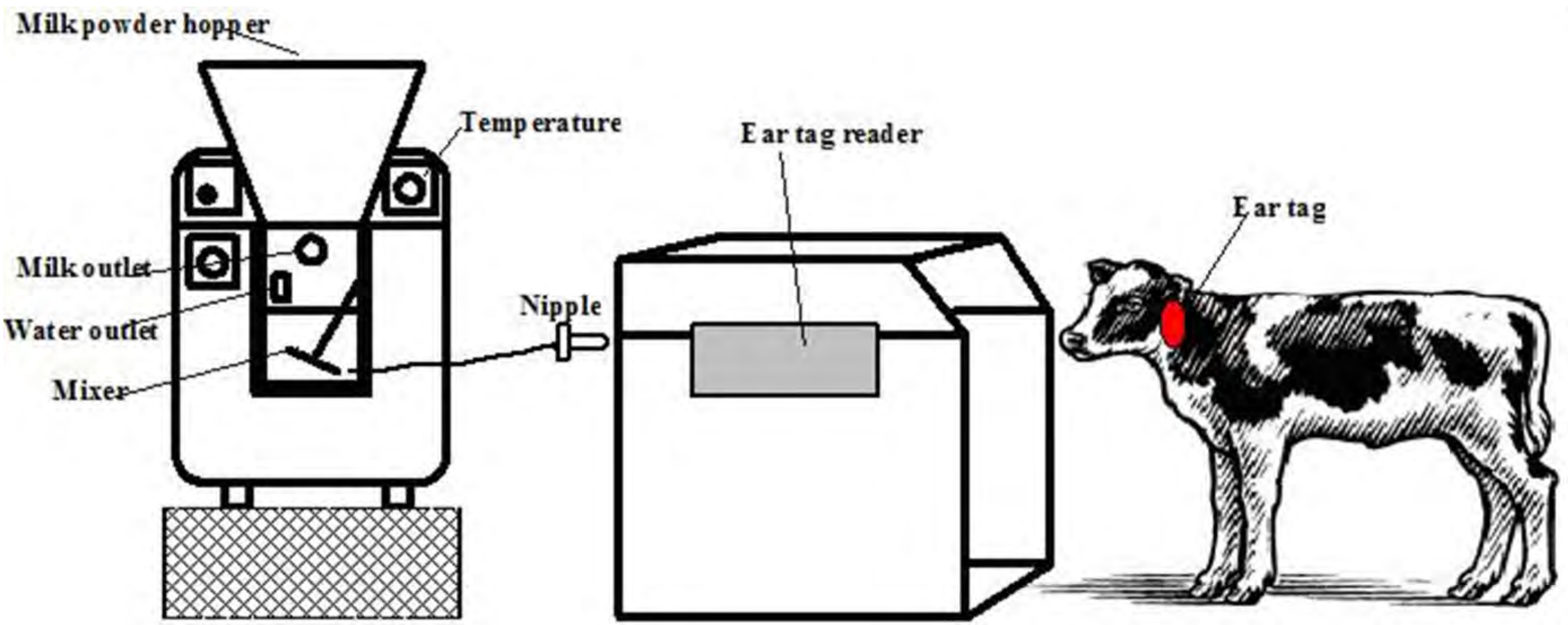
- Inexpensive ad lib feeding system
- Aim to prevent bacterial growth (preserve) in milk stored at room temperature
- Does not kill all bacteria (not a substitute for pasteurization)
- Concentrated formic acid is a dangerous compound at 85% level – care in handling (buy prediluted form)
- Formic acid illegal in the U.S. (Citric acid is a legal alternative)
- Milk must be kept at 20-24 °C:
  - Too warm: milk curdles
  - Too cold: limits intake
- Milk must be stirred frequently (3X)

http://www.omafra.gov.on.ca/english/livestock/dairy/facts/mimick.htm

Computer Feeders – Outline

- Sophisticated vs basic systems
- What have we learned:
  - pros / cons
  - What works, what doesn't work
- Summary of best management practices

Principles of calf autofeeders



Biotic industries, Bell Buckle, TN

"Sophisticated" Systems

Forster Technik, Germany

Delaval, GEA, Lely

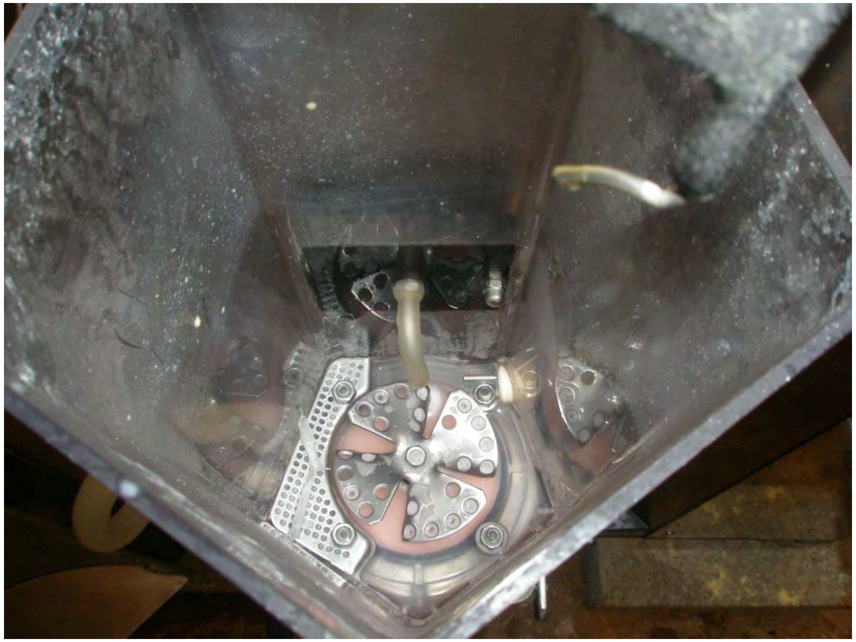
Photos – courtesy of Bob James, Tom Earleywine

Forster Technik, Germany

Delaval, GEA, Lely

Photo – courtesy of Bob James

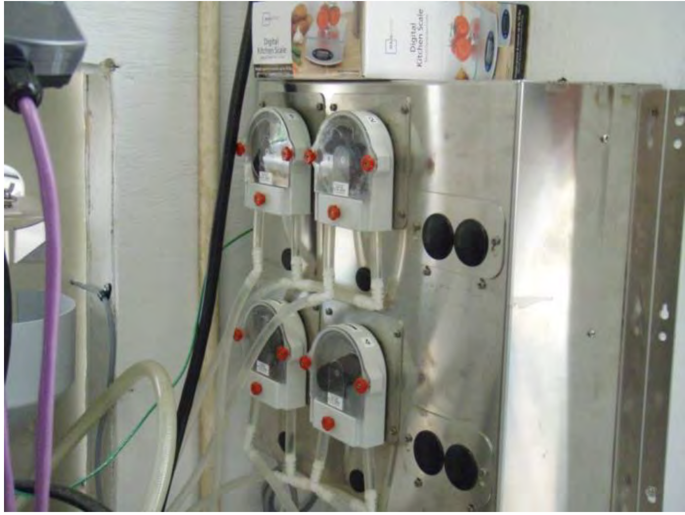
Mixing bowl – F.T.



Urban, Germany

Photo – courtesy of Bob James

“Sophisticated” Systems
(e.g. Forster Technik)



- $20,000-$25,000.
- One machine can dispense to up to 4 nipples/pens *(± at the same time???)*
- 25-30 calves per pen (Really?)
- Program desired meal sizes (no limit)
- CIP for dispenser / feeding hoses (not perfect; nipples?)
- Downloads intake records (meal times, duration, intake) to computer software: Aid in monitoring calves

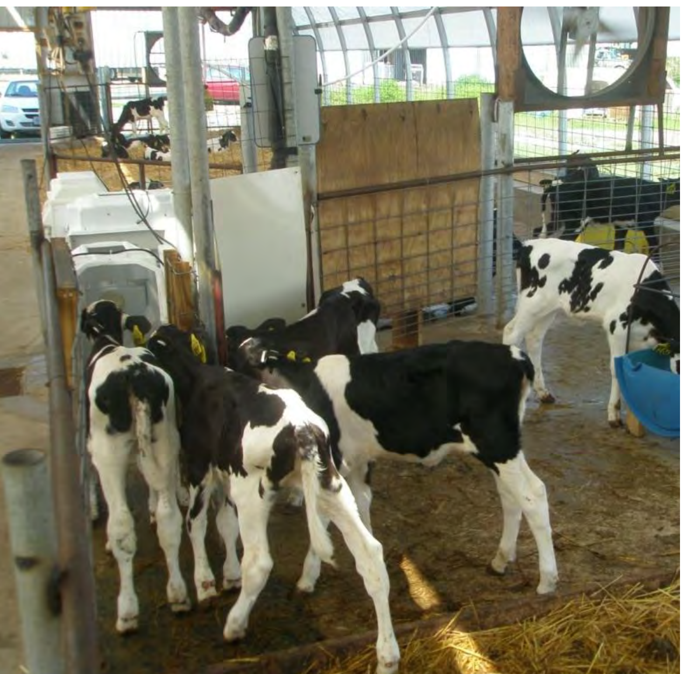
"Basic" Systems

Biotic

Bell Buckle, TN

Mixing bowl – Biotic

“Basic” Systems
(e.g. Biotic system)



- $2,500 for 1 machine
- 1 nipple: 1 group
- < 25 calves
- Max. 1 pint/mix (devel. for kids/lamb) => keeps mixing & delivering
  - Increased time => greater risk of calves waiting to get in
- Hopper holds 25 lbs powder
  - Must refill frequently
- Can review calf record for last 2 days at machine
- Manual cleaning

What have we learned about group housing and computer feeders?

- Consistency of…
  - Total solids (%)
  - Sanitation (bacteria counts)
  - Temperature of milk dispensed
- Age at introduction to group
- Training to feeder
- Group size
- Milk allowance (per meal, per day)
- Grain feeding
- Weaning
- Disease detection

Virginia Tech Research

Machado and James, 2011

- 10 dairies in VA and NC identified with feeders.
  - Survey of management
  - Measure:
    - Temperature
    - Standard Plate Count (SPC)
    - Brix refractometer to estimate solids.
  - 6 farms visited monthly between June and September

Bob James

Kayla Machado

Mean standard plate count (10^5), temperature (ºF), and refractometer (Brix) reading by machine type

Machine type	Variable	N	Mean	SD	Minimum	Maximum
Basic	SPC	89	69.25	73.71	0.00	500.00
	Brix	35	12.00	2.10	7.00	18.00
	Temperature	31	101.8	44.1	87	118
Sophisticated	SPC	44	13.39	22.03	0.00	88.00
	Brix	15	10.37	1.68	7.00	13.00
	Temperature	14	101.3	44.2	81	107

Virginia Tech 1872

Flowability of the powder matters to consistency of total solids delivered

Sanitation / Maintenance

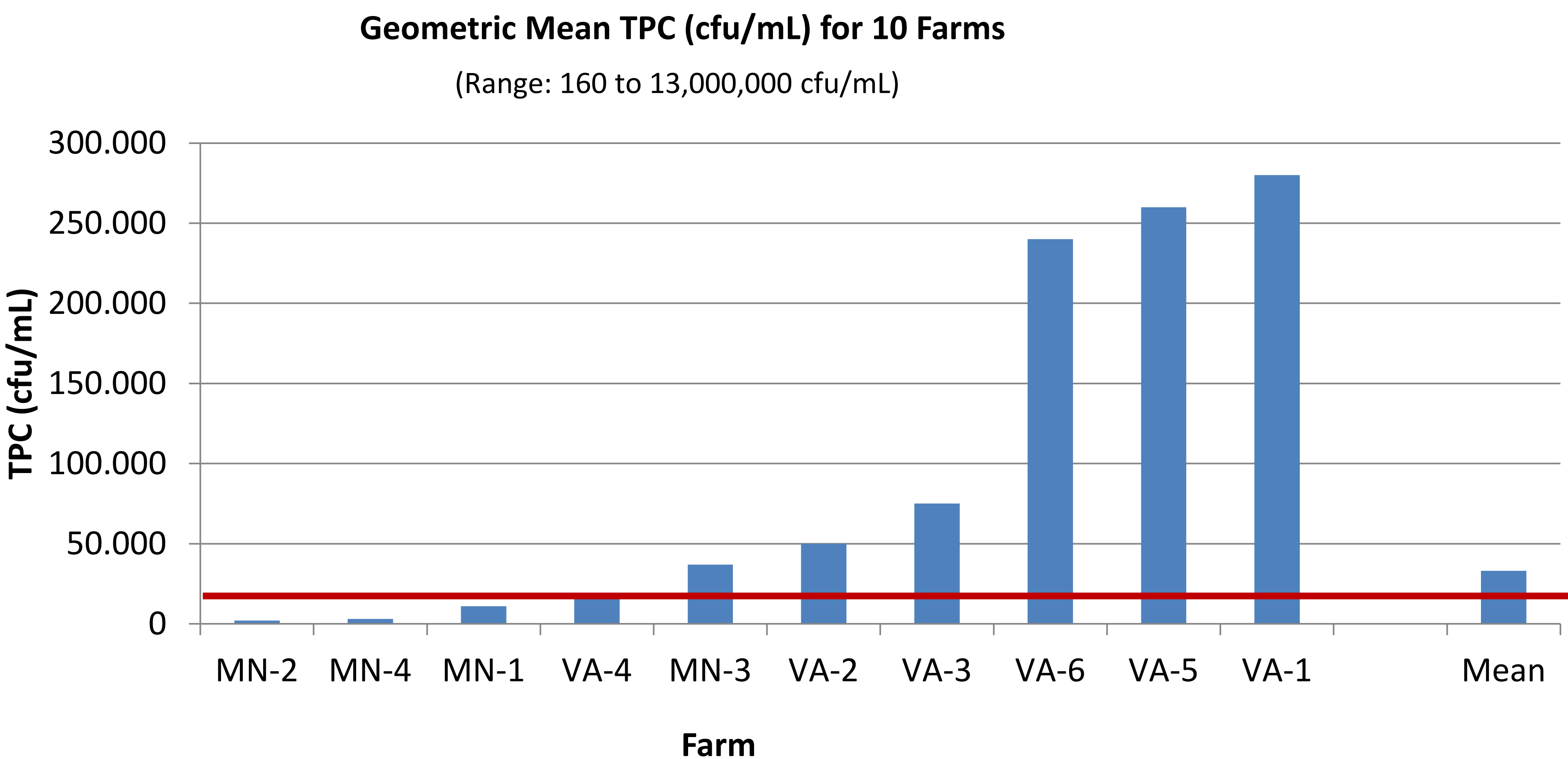
Photos – Courtesy of Tom Earleywine

Summary of Virginia Tech Survey Study

- TS and temperature highly variable
- Avg. bacteria counts exceed goal of 20,000 cfu/ml TPC
- Biotic (basic) systems appeared to require greater attention and maintenance than Förster-Technik (sophisticated) machines
- Producers with the assumption that calves can be fed and left alone were not satisfied with the autofeeder.

VA & MN Observational Study of Machine Sanitation

- 10 FT farms (6 in VA; 4 in MN)
- Milk sampled weekly or biweekly, Jan – Sept, 2014



Sanitation / Maintenance / Calibration

- Goal: TPC < 20,000 cfu/mL; coliforms < 10 cfu/mL
- Cleaning steps:
  - Verify water temp, sanitizing agents
  - Circuit clean daily
  - Switch out and disinfect nipples daily
  - Replace w new feeding hoses weekly
  - Monitor nipple condition & replace as needed
- Check total solids of mixture frequently
- Have distributor verify calibration frequently

Age at introduction to group? (Older is better. >12-14 days)

- Day 6 vs Day 14? Younger calves….
  - More restless 1st day after introduction (Rasmussen et al, 2006)
  - Need more guidance to feeder (Jensen, 2008)
  - Take longer to learn to adapt/drink at feeder (Fujiwara et al., 2014)

- Svensson et al., 2006. PVM 73:43
  - Randomized clinical trial evaluating group size: 892 calves in 9 Swedish herds
  - 50% Increased risk for respiratory disease if move into group at ≤ 12 days of age

Photo – Jensen - 2009

Training to the Feeder

- Skip morning feeding, place in autofeeder pen and lead to nipple.
- 90% learn in 2 trips;
  10% need more 'assisted' trips
- Don't overdo it (kill them with kindness), or calves will associate a person's presence with being fed
- Avg. 1.5 days to train a new pen of calves

(Tom Earleywine, Bob James)

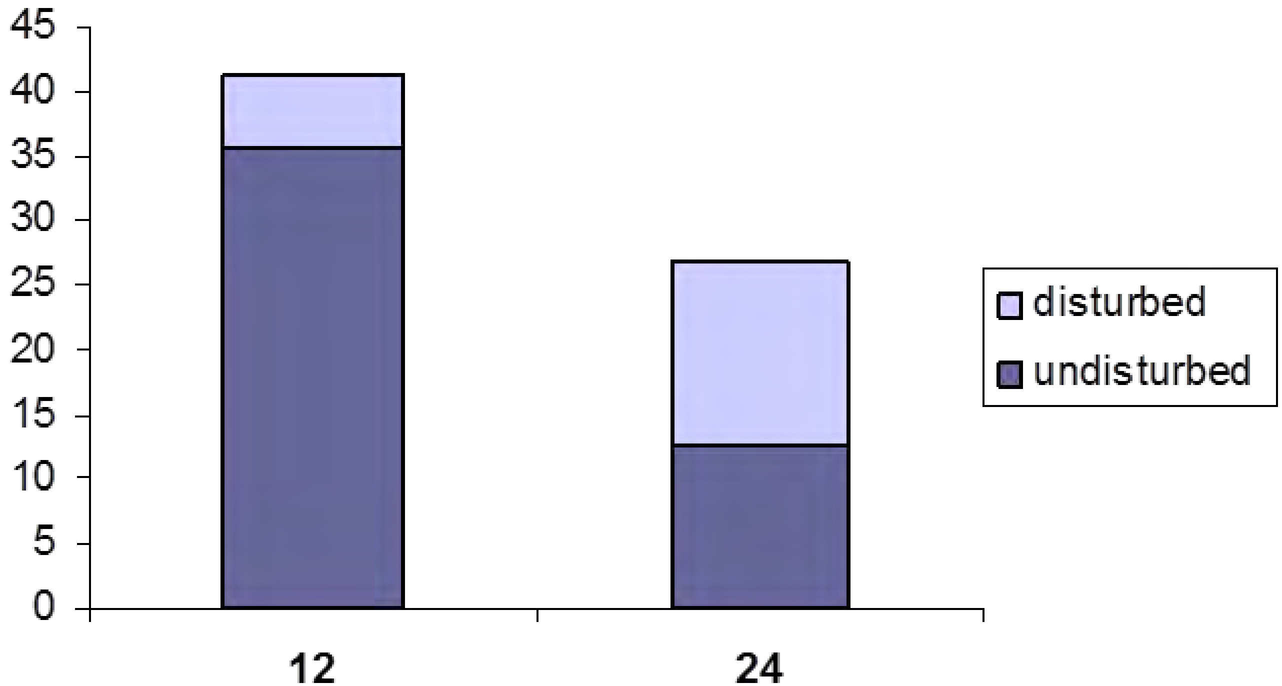
Group Size
(Smaller is better < 8-10 calves)

- Distributors often recommend 25–30 per station
- Many herds have less than 20 calves per feeder (Bob James, 2012)

- Issues surrounding group size:
  - Crowding => Disease risk
  - Competition at feeder => stress
  - Can all calves consume their daily allowance? => restricted intakes & associated problems

Group size:
Effects on occupation of feeders

Min. / calf / 24 h



Bigger group sizes = less time at feeder and more competition and disturbance (Jensen, 2004. JDSci. 87:3428)

Group Size is a Risk Factor for Morbidity in Group Housed Calves

- Svensson et al., 2006. PVM 73:43
  - Randomized clinical trial: 892 calves in 9 Swedish herds
  - Calves randomized to small (6-9) vs Large groups (12-18)
  - Large groups:
    - 40% increased risk for respiratory disease
    - Reduced growth rate

Health of Single Pen vs Group Housed Calves

- Svensson et al., 2003. PVM 58:179
  - Observational study: 3081 calves in 122 Swedish herds
  - Incidence of respiratory disease(%)
    - Single pen: 3.5% [a]
    - Small groups (3-6 calves): 3.3% [a]
    - Large groups (8 to 30 calves): 7.4% [b]
- Losinger et al., 1997. J. Dairy Res. 64:1
  - USDA national study: 47,057 calves in 1685 US herds
  - Mortality risk was 40-52% higher in large groups (≥ 7/group) as compared to single pen or small groups (2-6/group)

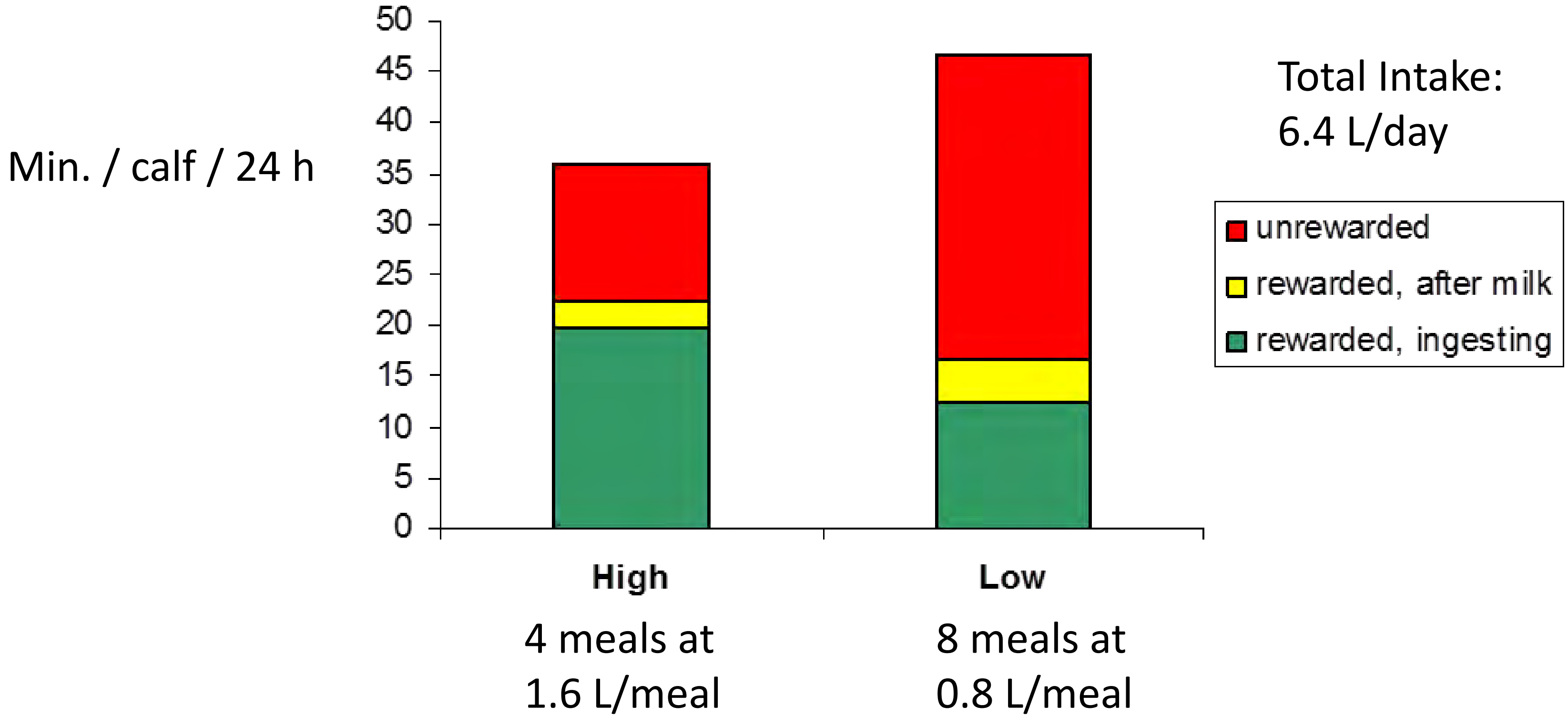
Pen Dynamics

- All in – All out
- Hard to do on all but the largest dairies
- Mixing young with older calves:
  - Competition
  - Disease can become endemic within pen

Barn / Pen Environment

- Ventilation
- Bedding Management
  - Clean
  - Dry
  - Comfortable
  - Deep bedded straw in winter
  - Slatted floors are hard on calves:
    - Chilling
    - Uncomfortable / reduced lying time
    - Joint injury

Effect of Meal Milk Allowance per calf on Occupation of Feeders



Lower milk allowance per meal = more time in feeder / more unrewarded visits. (Jensen, 2004. JDSci. 87:3428)

Effect of Daily and Meal Milk Allowance on Calf Behavior

Rushing the Feeder

Full, relaxed, sleeping

Photos – Courtesy of Bob James, 2012

Cross sucking - IF calves are fed enough per meal and per day, this is less of a problem!

Recommended Milk Allowance

- 1.8 to 2.8 lbs DM per day fed as 12-15% Total solids mixture (approx. 1.5 – 2.5 gallons/day)

- 2 to 2.5 L per meal

- Most calves will consume around 3-5 meals per day (sophisticated systems)

(Tom Earleywine, Bob James)

Photo – Courtesy of Bob James

Example Feeding program

(Backgrounded 12 days)

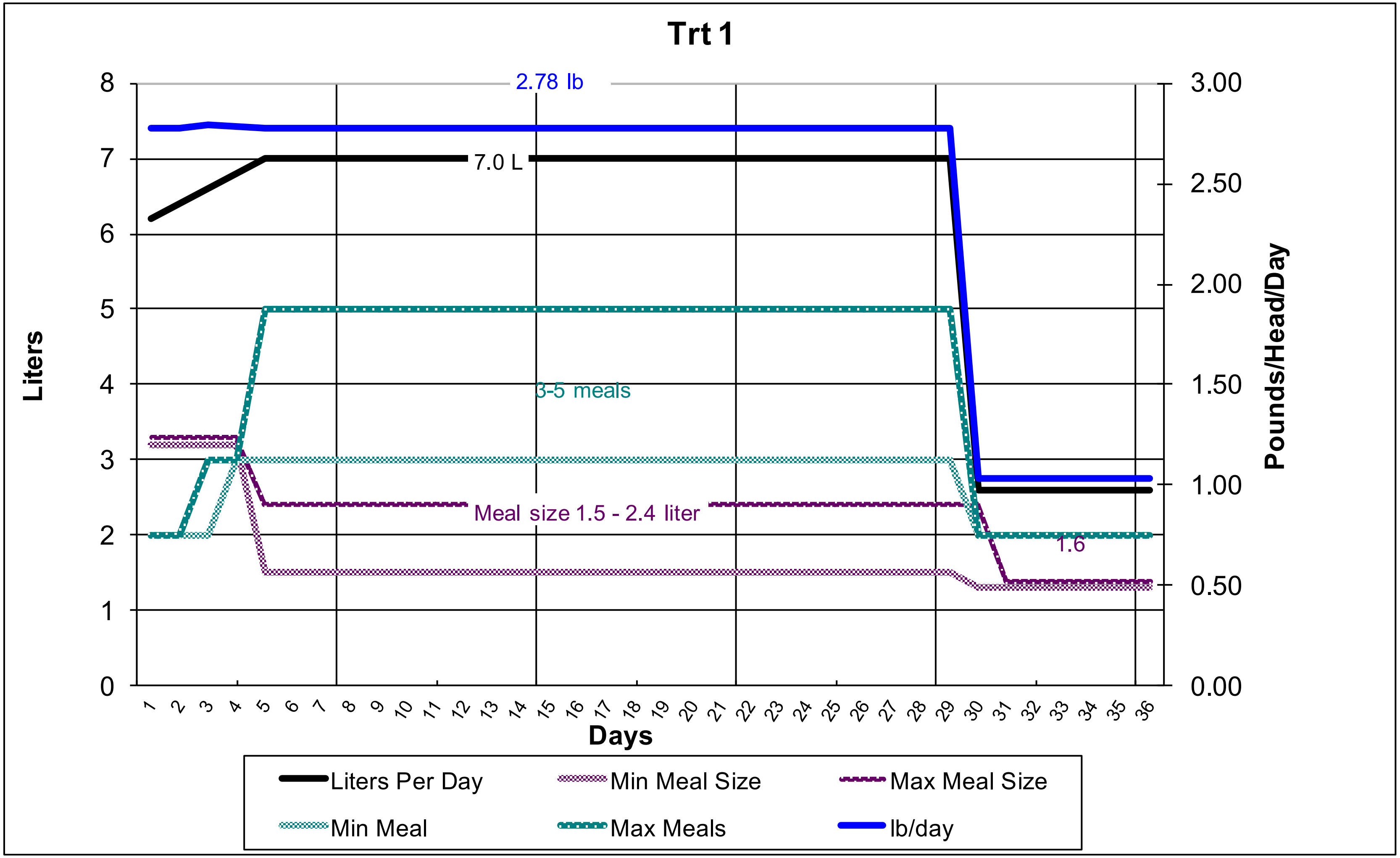


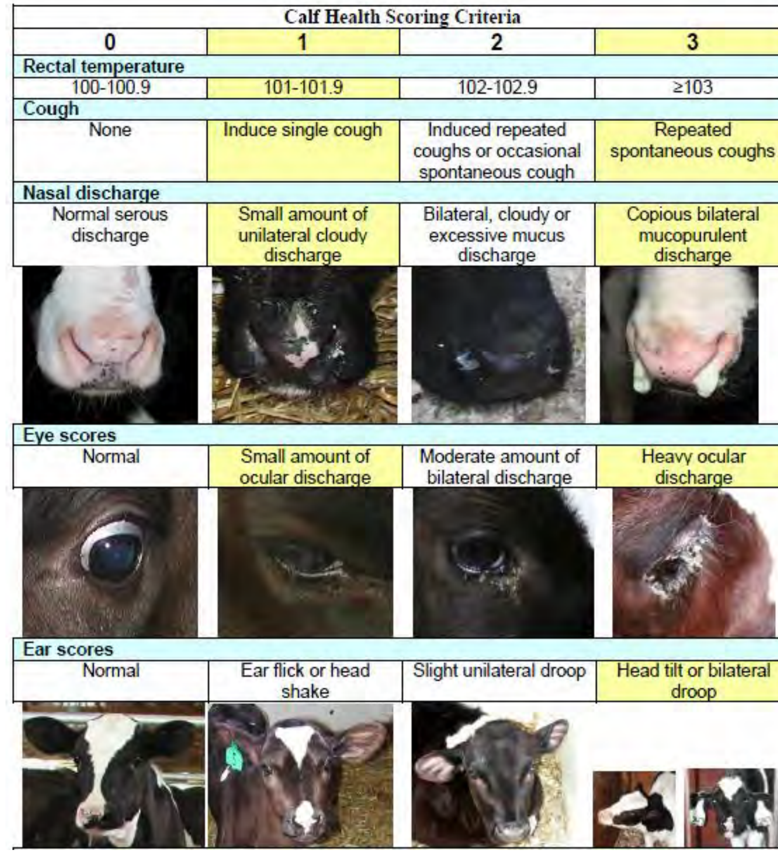
Figure – courtesy of T. J. Earleywine

Preliminary analysis of factors associated with abnormal health scores in computer-fed group housed calves

(M. Endres, Precision Dairy Conference. July, 2015)

- Methods:
  - 38 farms in MN, WI, IA
  - Visited every 60 days from Nov. 2012 – May 2014

- Risk factors associated with abnormal health scores:
  - Number of calves per group
  - Space per calf
  - Peak milk allowance
  - Time to reach peak milk allowance
  - Air speed in resting/feeding area
  - SPC – hose samples > 100,000 cells/mL



Calf Health Scoring Criteria

0	1	2	3
Rectal temperature			
100-100.9	101-101.9	102-102.9	≥103
Cough			
None	Induce single cough	Induced repeated coughs or occasional spontaneous cough	Repeated spontaneous coughs
Nasal discharge			
Normal serous discharge	Small amount of unilateral cloudy discharge	Bilateral, cloudy or excessive mucus discharge	Copious bilateral mucopurulent discharge
Eye scores			
Normal	Small amount of ocular discharge	Moderate amount of bilateral discharge	Heavy ocular discharge
Ear scores			
Normal	Ear flick or head shake	Slight unilateral droop	Head tilt or bilateral droop

Modified McGuirk Health Scoring System

Add on Technologies: **Feeding pasteurized waste milk through autofeeders (vs milk replacer)**

- Can be done, but increases logistical challenges
  - Milking fresh and hospital cows
  - Pasteurize
  - Cool & store
  - Deliver to the autofeeder
  - Rewarm
  - Monitor pasteurizer function
  - Cleaning/sanitation of entire system

CalfStar, Inc., WI

Add on Technologies: **Auto grain feeders**

Forget them: They restrict grain intake

Provide free access to grain in pen

Photos – courtesy of T. J. Earleywine

Add on Technologies: **Automated feeding of individual calves**

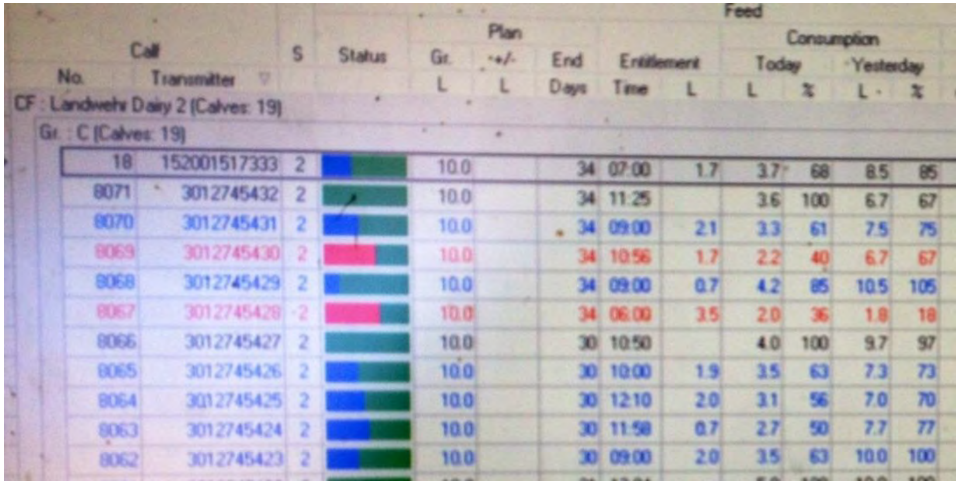
(CalfRail System. Förster Technik)

- Potential uses:
  - Backgrounding
  - Entire milk feeding period
- Potential benefit: Not grouping
- Remains to be validated:
  - Cleaning?
  - Maintaining milk temperature / frozen lines in winter?
  - Disease transmission via nipple?

Disease Detection in Group Housed Calves?

- Sophisticated computer feeder reports (per day):
  - Total consumption (L/d)
  - Drinking speed (mL/min)
  - Visits to the feeder (#/day)

- Flags calves based on 25% deviation in milk intake, comparing last 24 hrs to previous 72 hrs



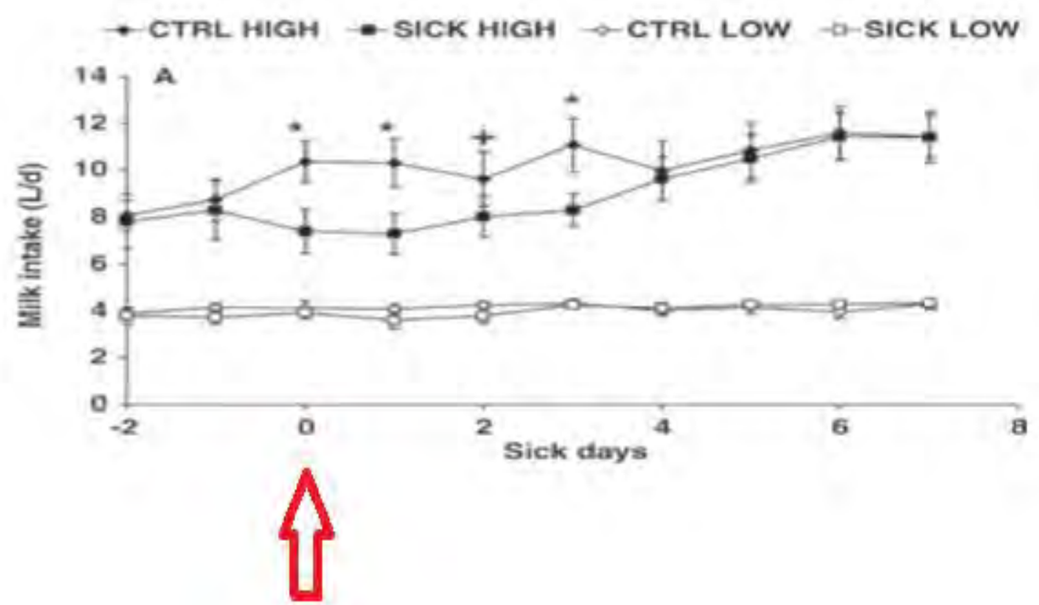
Computer screen in office

Hand held unit at machine

How well does the computer help to find sick calves?

- The computer may not be timely or sensitive compared to a human observer

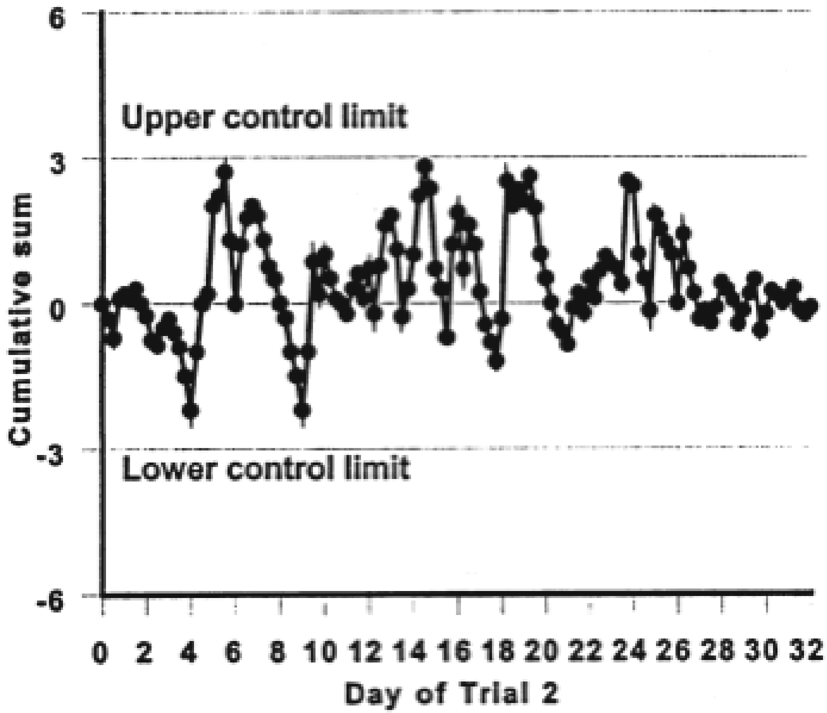
- Still need a person looking at the calves



(Borderas 2009)

Statistical Process Control:
A possible solution to disease detection?

- Statistical Process Control
  - Uses the theory of variation to explain process change
- If we apply SPC to calf feeding behaviors, would this detect disease in a more timely and sensitive manner?



(Quimby et al, 2001)

Summary:
Autofeeders and Group Housing systems…

- Can…
  - Add flexibility to labor (reallocation)
  - Be an efficient tool for delivering a good nutrition program
- Are not…
  - The answer to poor calf management (colostrum, biosecurity, nutrition, bedding, ventilation,…)
  - The answer for people who don’t want to spend time managing calves
  - Can see significant increases in morbidity

Summary of challenges in using group housing/autofeeders

- Biosecurity / disease control
- Potential competition for resources: feed / space
- Detecting sick calves
- Machine cleaning, maintenance, calibration and monitoring

Summary of Best Management Practices for Group Housing

- TRUE FOR ALL CALF SYSTEMS:
  1. Excellent colostrum management
  2. Do not restrict milk intake (large meal/daily allowances)
  3. Do not delay 'ramp up' to peak milk allowance
  4. Excellent ventilation
  5. Clean, dry, abundant bedding
  6. Free choice water and high quality starter pellet
  7. Frequent observation to find sick calves early

Summary of Best Management Practices for Group Housing

- SPECIFIC to GROUP HOUSING:

8. Delay introduction (> 12-14 days)

9. Small group sizes (< 8-10 calves)

10. Don't overcrowd (> 40 ft^2/calf)

11. Manage as all in – all out system (narrow range of ages)

12. Sanitation, calibration and monitoring of autofeeder

My last point

- Regardless of feeding and housing system used, there are big advantages to feeding more milk

- Our challenge:
  - Select the best system for the farm's circumstances
    and/or
  - Best manage the housing/feeding system already in place

Thank you!

Care of the Newborn Calf

Sandra Godden DVM, DVSc
College of Veterinary Medicine
University of Minnesota

Goals for calf health and growth between birth and weaning

Parameter	**Goals**	
Stillbirth Rate (%)	< 6% [1]	
Mortality Rate (%)	< 5% [2]	
Scours Rate (%)	< 25% [2]	
Pneumonia Rate (%)	< 10% [2]	
Growth Rate (kg/day)	Double birth weight [2] (ADG ≈ 0.7 kg/day)	

[1] S. McGuirk. AABP, 2015; [2] Dairy Calf and Heifer Association Gold Standards; [3] USDA, 2016; [4] USDA, 2007

Goals for calf health and growth between birth and weaning

Parameter	Goals	Actual
Stillbirth Rate (%)	< 6% [1]	5.6% [3]
Mortality Rate (%)	< 5% [2]	7.8% [4]
Scours Rate (%)	< 25% [2]	23.9% [4]
Pneumonia Rate (%)	< 10% [2]	12.4% [4]
Growth Rate (kg/day)	Double birth weight [2] (ADG ≈ 0.7 kg/day)	?

[1] S. McGuirk. AABP, 2015; [2] Dairy Calf and Heifer Association Gold Standards; [3] USDA, 2016; [4] USDA, 2007

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So how do we achieve these goals?

[1] S. McGuirk. AABP, 2015; [2] Dairy Calf and Heifer Association Gold Standards; [3] USDA, 2016; [4] USDA, 2007

Key management areas affecting calf wellbeing and performance

- Dry cow management
- **Maternity pen/calving management**
- **Newborn care**
- **Colostrum management**
- Nutrition
- Housing
- Sanitation
- Disease detection, diagnosis & treatment
- Pain management

Outline:
Care of the Newborn Calf

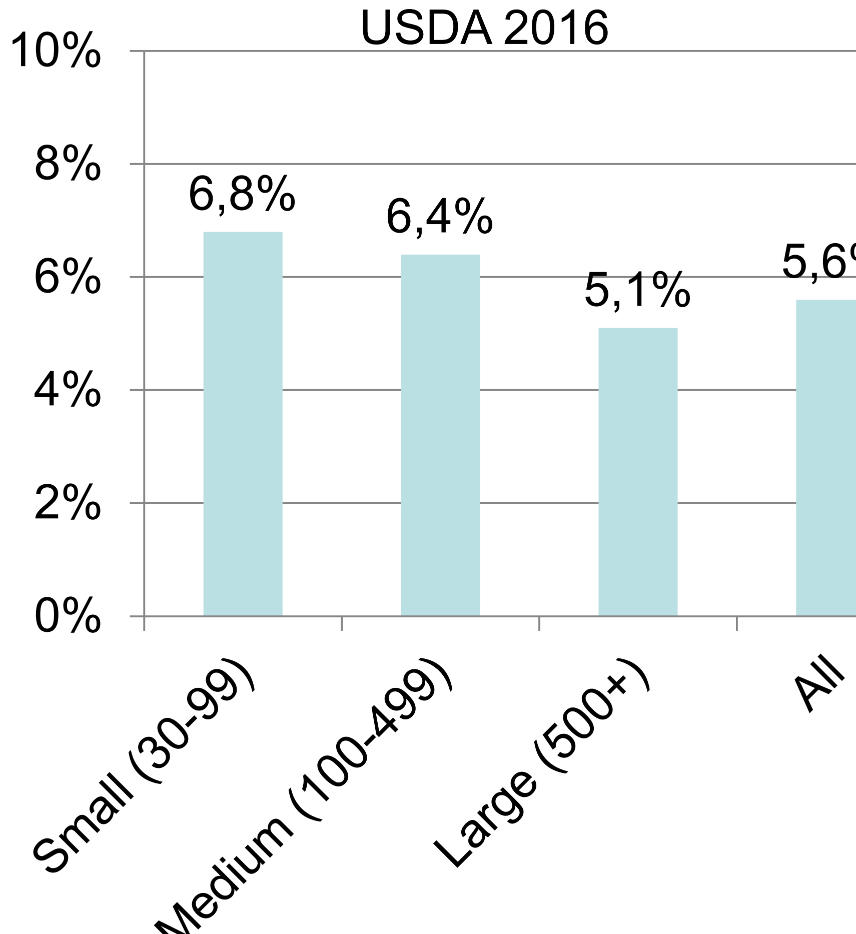
- **Calving management**
- Assessing calf vigor
- Resuscitation and critical care
- Routine health management procedures
- Colostrum management



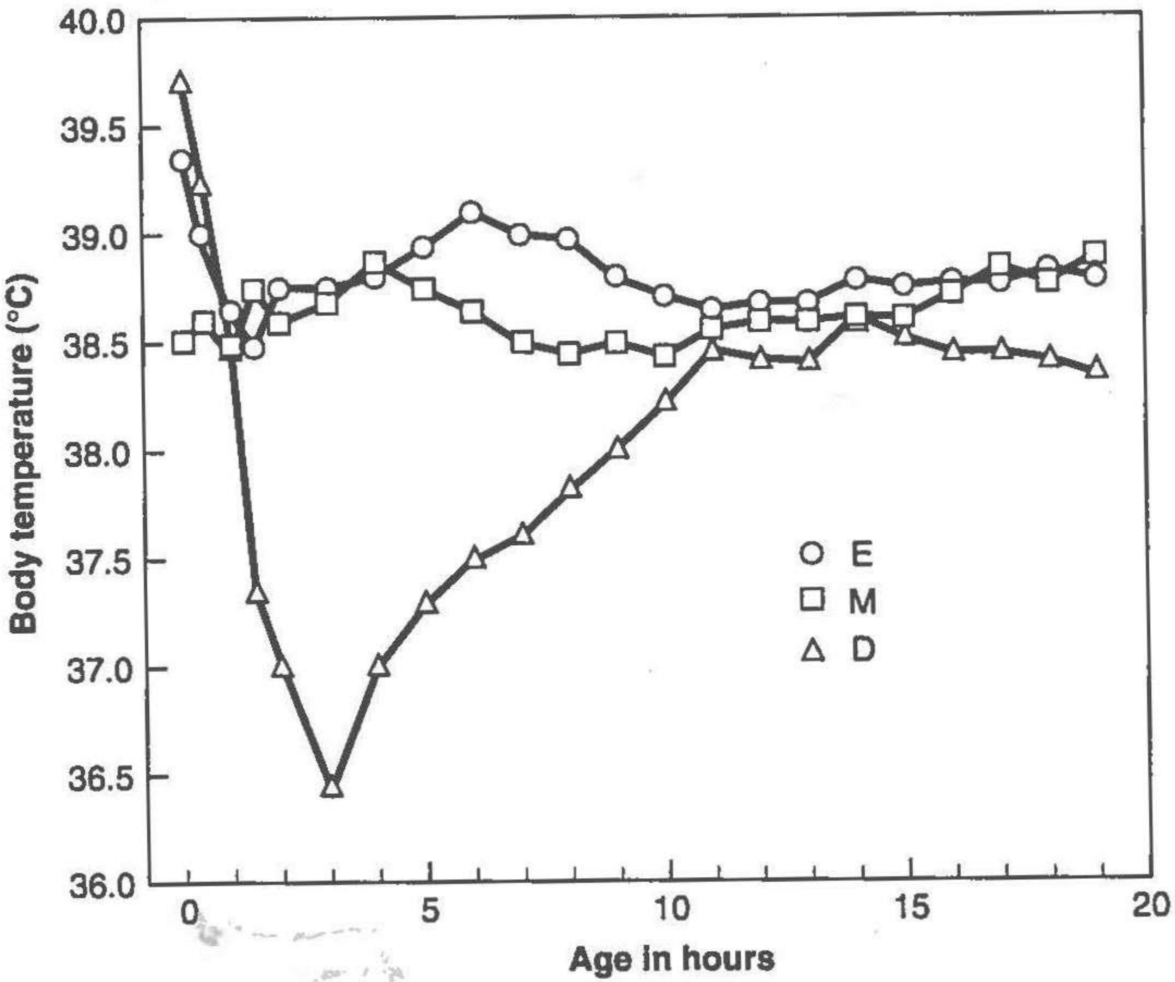

Stillbirths on U.S. Herds

(born dead or die within 48 hrs)

- Goal < 6% (S. McGuirk. AABP, 2015)
- Actual:
  - USDA 2007: 6.5%
  - USDA 2016: 5.6%
- 1 in 5 stillbirths are born alive, but die within 48 hr



Dystocia - a major disadvantage for survival



○ Eutocia

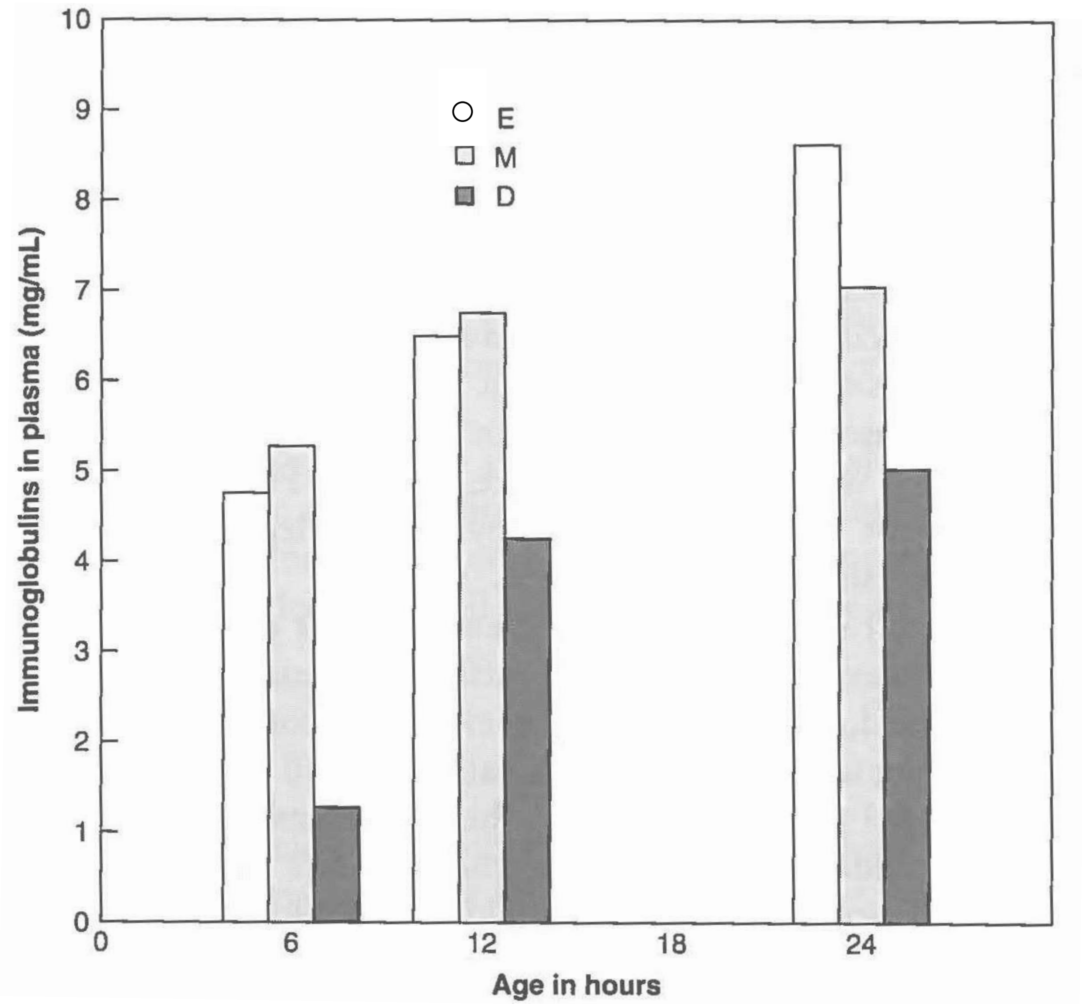
□ Moderate dystocia

Δ Severe dystocia

- Decreased rectal temperature of calves after severe dystocia births due to decreased muscle activity

Davis and Drackley, 1998

Dystocia - a major disadvantage for survival



○ Eutocia

□ Moderate dystocia

Δ Severe dystocia

- Decreased immunoglobulin (Ig) absorption in calves after severe dystocia births

Davis and Drackley, 1998

Calving management: Mitigating effects of dystocia

- Facility design
- Regular evaluation of the maternity pen environment

- Protocols and training:
  - What is normal (time/progress/position)?
  - When should I assist?
  - How do I assist (clean, gentle, lube)?
  - When do I call the vet?

- Records / Monitoring
- Emphasis on calving ease bulls

Outline:
Care of the Newborn Calf

- Calving management
- **Assessing calf vigor**
- Resuscitation and critical care
- Routine health management procedures
- Colostrum management

Assessing Calf Vigor

- What?
  - Identify stressed or at-risk calves that require immediate resuscitation or more intensive supportive care
- Who? Calves experiencing dystocia/assisted birth are often:
  - Hypoxic
  - Acidotic
  - Weak
  - Painful

- Why?
  - Early intervention => Reduce stillbirths and improve short and long-term outcomes

Using behavior/physiologic measures to assess calf vigor

	Normal	Abnormal
Lift/right head	< 3 min	Delayed
Sternal recumbency	< 5 min	Delayed
Attempt to stand	< 20 min	Delayed
Standing	< 1 hr	Delayed
Respiratory Rate (breaths/min)	50-75	Irregular, slow or rapid
Heart Rate (beats/min)	90-160	Irregular, slow or rapid

(Mee, VCNA. 2008; McGuirk, AABP. 2015)

Other signs of poor vigor or ‘at risk’ calves

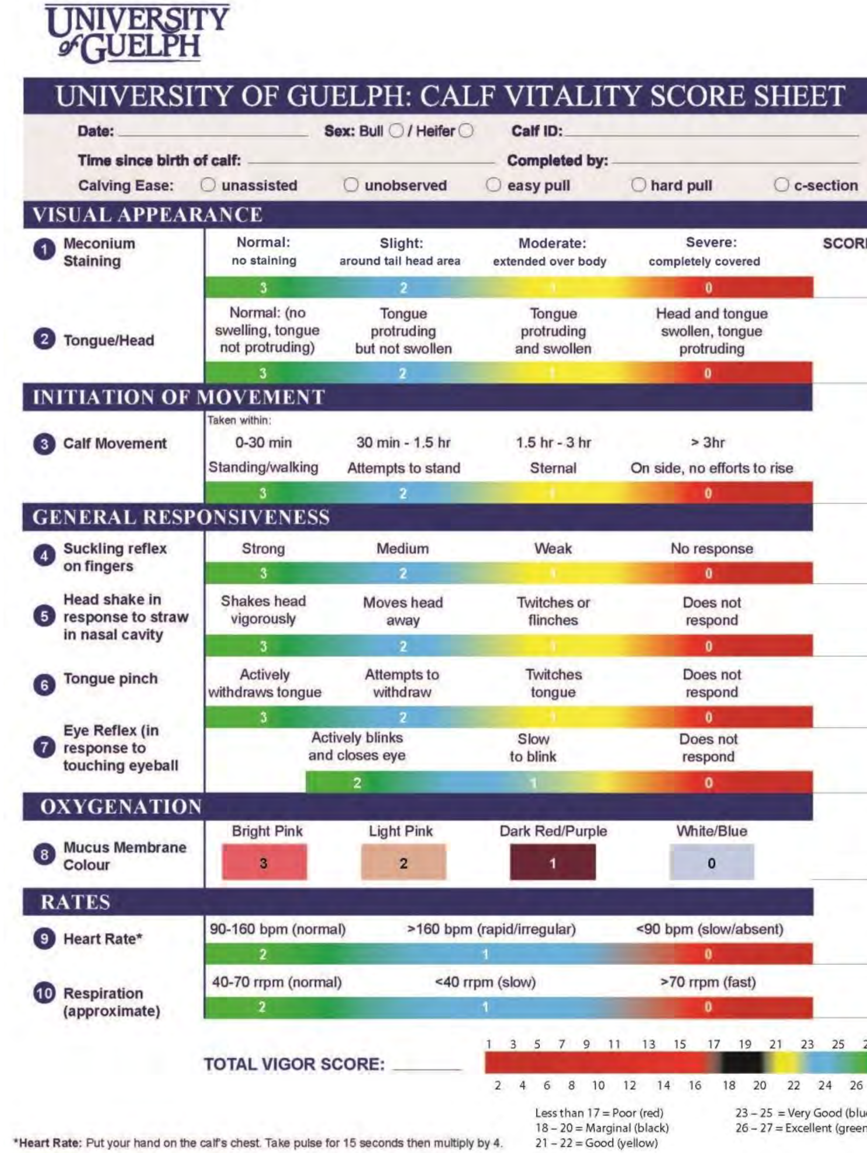
- Weak / poor reflexes
- Blue (cyanotic) mucous membranes
- Petechial hemorrhages of sclera and conjunctiva
- Swollen head/tongue
- Meconium staining

(McGuirk, AABP. 2015)

University of Guelph VIGOR Scoring System

- **V**isual appearance
- **I**nitiation of movement
- **G**eneral responsiveness
- **O**xygenation
- Heart and respiration **R**ate

- Calves with lower cumulative scores have poor vigor, and may need immediate attention (Murray et al., Bov. Pract. 2015)



UNIVERSITY of GUELPH

UNIVERSITY OF GUELPH: CALF VITALITY SCORE SHEET

Date: ______ Sex: Bull ◯ / Heifer ◯ Calf ID: ______

Time since birth of calf: ______ Completed by: ______

Calving Ease: ◯ unassisted ◯ unobserved ◯ easy pull ◯ hard pull ◯ c-section

	3	2	1	0	SCORE
VISUAL APPEARANCE					
1 Meconium Staining	Normal: no staining	Slight: around tail head area	Moderate: extended over body	Severe: completely covered	
2 Tongue/Head	Normal: (no swelling, tongue not protruding)	Tongue protruding but not swollen	Tongue protruding and swollen	Head and tongue swollen, tongue protruding	
INITIATION OF MOVEMENT					
3 Calf Movement	Taken within: 0-30 min Standing/walking	30 min - 1.5 hr Attempts to stand	1.5 hr - 3 hr Sternal	> 3hr On side, no efforts to rise	
GENERAL RESPONSIVENESS					
4 Suckling reflex on fingers	Strong	Medium	Weak	No response	
5 Head shake in response to straw in nasal cavity	Shakes head vigorously	Moves head away	Twitches or flinches	Does not respond	
6 Tongue pinch	Actively withdraws tongue	Attempts to withdraw	Twitches tongue	Does not respond	
7 Eye Reflex (in response to touching eyeball		Actively blinks and closes eye (2)	Slow to blink (1)	Does not respond (0)	
OXYGENATION					
8 Mucus Membrane Colour	Bright Pink	Light Pink	Dark Red/Purple	White/Blue	
RATES					
9 Heart Rate*		90-160 bpm (normal) (2)	>160 bpm (rapid/irregular) (1)	<90 bpm (slow/absent) (0)	
10 Respiration (approximate)		40-70 rrpm (normal) (2)	<40 rrpm (slow) (1)	>70 rrpm (fast) (0)	

TOTAL VIGOR SCORE: ______ (1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27)

Less than 17 = Poor (red)
18 – 20 = Marginal (black)
21 – 22 = Good (yellow)
23 – 25 = Very Good (blue)
26 – 27 = Excellent (green)

*Heart Rate: Put your hand on the calf's chest. Take pulse for 15 seconds then multiply by 4.

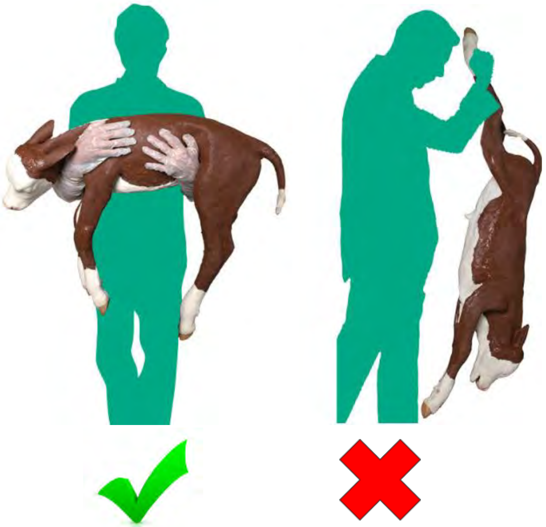
Outline:
Care of the Newborn Calf

- Calving management
- Assessing calf vigor
- **Resuscitation and critical care**
- Routine health management procedures
- Colostrum management




Simple steps to resuscitation

- 'ABC' of resuscitation:
  - Establish open **A**irway
  - Stimulate **B**reathing
  - Provide **C**irculatory support



- Stimulate breathing as soon as calf thorax emerges (even if hip-locked)
- Clear mouth & nose of fluid with fingers
- Use postural drainage
- Sit calf in sternal ('dog sitting') position

(McGuirk. AABP, 2015)

Simple steps to resuscitation (con't)

- Rub briskly with towel (rump to head)

- Acupuncture of nasal philtrum or pinch nasal septum
- Pour ice water on head or in ear to induce gasp reflex

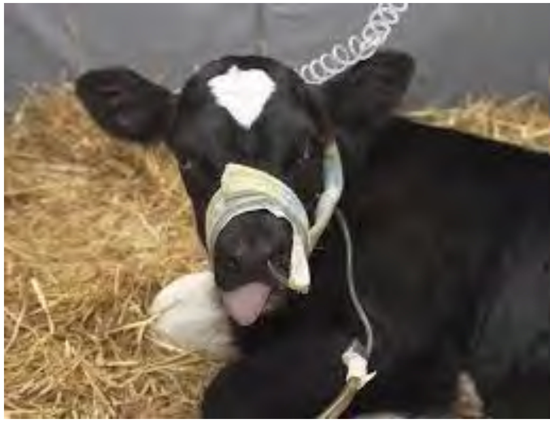
- Identify and monitor closely

(McGuirk. AABP, 2015)

More advanced support

- Compressed air devices or intranasal O_2 (2 people, training and equipment)
- Sodium bicarbonate (50-100 mL of 8.4% solution I.V.)
- Glucose (5 g bolus I.V.)
- Doxapram is NOT recommended: Transient effects only => post-treatment relapse and respiratory depression

McCulloch Medical™ Calf Aspirator/Resuscitator Kit

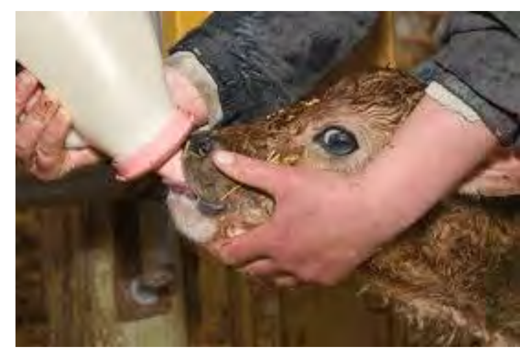


(McGuirk. AABP, 2015)

Pain Management

- Dystocia/assisted calving is a painful process
  - Soft tissue injury / inflammation
  - Torn diaphragm, ruptured liver, etc.
  - Fractured ribs, legs

- Meloxicam (Metacam®. Boehringer Ingelheim Vetmedica Inc):
  - Non-steroidal anti-inflammatory
  - 1 mL SQ (20 mg/mL) at birth:
    - Improved vigor and suckling reflex
    - Following assisted calving, treatment improved health and weight gain in first wk



(Murray et al., JDSci. 2015 a,b)

  - Approved for pain management in Canada. ELDU in U.S.

Outline:
Care of the Newborn Calf

- Calving management

- Assessing calf vigor

- Resuscitation and critical care
- **Routine health management procedures**

- Colostrum management

Routine Health Management Procedures

- Identification and records
- Calf movement
- Umbilical care
- Drying / warming
- Disease testing
- Treatments?

CALF INFORMATION

Cow ID	Calf ID	Sire ID	Birth Date	Birth Weight
S122	W001	3067	09/05/09	83
T037	W002	3067	09/07/09	92
T205	W003	3067	09/12/09	54
T205	W004	3067	09/12/09	61
T050	W005	3067	09/13/09	79
N094	W006	T097	09/13/09	85
L198	W007	T097	09/18/09	88
R210	W008	L0165	10/08/09	78
R074	W009	L0165	10/12/09	90
M115	W010	L0165	10/21/09	81

CALF INFORMATION

Calf Sex	Calving Ease Score	Cow BCS	Notes
H	1	6	
B	3	6	
H	1	6	Twin to bull calf
B	1	5	Twin to heifer calf
B	1	6	
B	1	5	Dam – bad disposition
H	1	4	
H	2	5	
H	1	5	
B	1	5	

Calf movement: When should we separate the calf and dam?

- Pros of leaving calf with dam:
  - Allows bonding = natural (public perception)
  - Licking stimulates calf to breath, stand
- Pros of early separation:
  - Prevents bonding – reduces stress when separate
  - Reduced exposure to infectious agents
- Science/opinion supports both views
- North American systems would need to change to allow continued contact
- The future? Stay tuned for more discussion

(Ventura et al. JDSci. 2013)

Preventing Umbilical Infections

- Incidence: 1-14% *
- Prevention:
  - Colostrum management
  - Clean maternity & calf pens
  - Dip navels shortly after birth
- Navel dipping:
  - 7% Tincture of Iodine
  - Navel-Guard (SCG-Solutions, GA)
  - Do NOT use teat dips

- Industry adoption of navel dipping:
  - 118 QC farms: 37% didn't dip navels (von Keyserlingk et al., 2009)

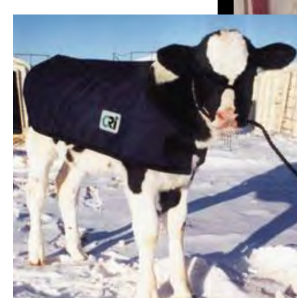
(* Donovan, 1998; Rings, 2009; USDA, 2010; Virtala 1996; Grover & Godden, 2011)

Warming / Drying

- Preventing hypothermia & frostbite

- Calf MUST be dry before placing in a cold environment, then placed out of wind and precipitation

- Drying options:
  - Warming box
  - Heat lamps
  - Heated room
  - Sanitation matters!



- Apply blanket AFTER the calf is dry
- Deep straw bedding in winter

Disease Testing

- Bovine Viral Diarrhea Persistent Infection (BVDV PI):
  - Positive or ‘at risk’ herds
  - Ear notch or blood sample
    - IHC
    - Antigen-capture ELISA
    - PCR
    - Virus isolation

  - If positive:
    - Retest calf in 3 weeks (acute infection vs PI)
    - If confirmed, send calf to slaughter
      (May be held liable if sold to other dairies)
    - Test the dam

Treatments?

- Vitamin A, D, E and selenium injections:
  - May not be needed if dry cows supplemented adequately and good colostrum management
  - May be indicated in deficient regions
  - PLEASE use a NEW NEEDLE!

- Vaccines? To be covered elsewhere

- Other? “Show me the data”

Outline:
Care of the Newborn Calf



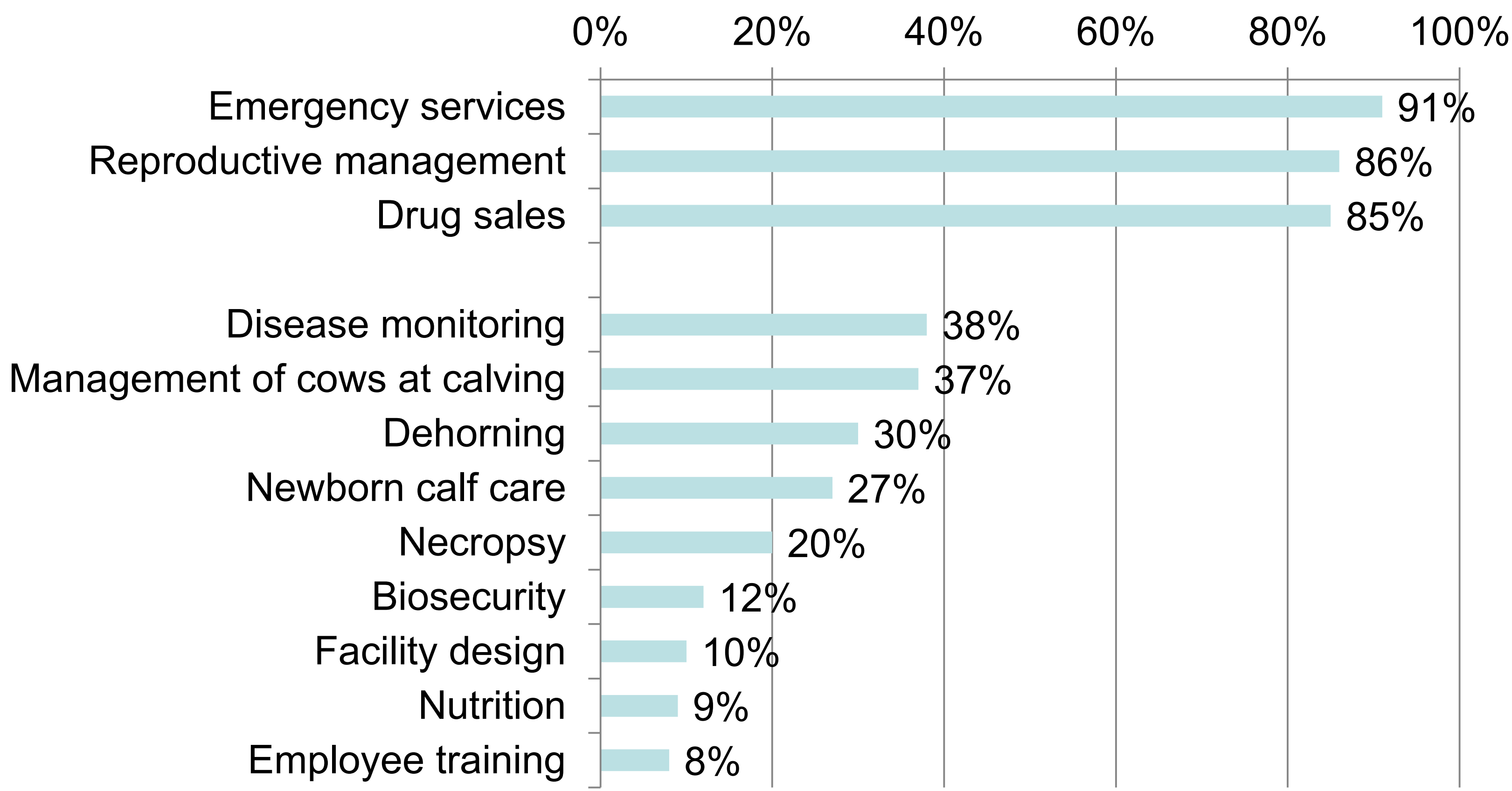

- Calving management
- Assessing calf vigor
- Resuscitation and critical care
- Routine health management procedures
- Colostrum management

Summary

- Newborn care has short and long-term impacts on calf wellbeing and performance
- Managers must make this a priority area
- Developing the program:
  - Set goals
  - Specialized facilities and equipment
  - Protocol development
  - Educate and train (& retrain) staff
  - Records / monitoring

Opportunity for increased veterinary involvement

Of the 94% of operations that used a veterinarian, percentage of operations by services provided by the vet (USDA, 2016)



As we look to the future…

- Increased emphasis on newborn care by managers and vets
- Opportunities for improvement:
  - Calving management
  - Assessing calf vigor
  - Resuscitation / critical care
  - Pain management
  - Colostrum management

- Question yet to be addressed:
  - When (how) will we separate the calf and dam?

Thank you!

Pasteurized Milk Feeding Systems:

Capturing the Benefits and Avoiding the Pitfalls

Sandra Godden DVM, DVSc
College of Veterinary Medicine
University of Minnesota

Outline:

- Pasteurizing milk:
  - Types of milk pasteurization systems
  - Potential benefits
  - Making the system work for you:
    - Avoiding the pitfalls
    - Monitoring

Pasteurization

- Pasteurization ≠ Sterilization
- Heat milk to a target temperature and for a target period of time for a given microbe.
- Goal: Reduce or eliminate pathogen exposure to calves.
- Milk Fed:
  - Discard milk: transition + treated milk
  - Tank milk

Goodnature Products, Inc.

U.S. farms feeding pasteurized milk

Year	Small dairies < 100	Medium 100-499	Large 500+	All
2007	2.3%	4.6%	31%	4.2%
2014	1.5 - 5.1%*	9.9%	43.8%	7.4%

* Very small (<30) and small categories reported separately

Pasteurizer Designs:
Batch Pasteurizers

- 145 ^{o}F (63 ^{o}C) x 30 minutes
- 10 – 300 gallon batches
- 1.5 to 3+ hrs (depends on batch size)
- Agitator
- Automated heat & cool cycle
- Manual or CIP wash system
- Cost: $5000 - $10,000+

DairyTech 30 batch pasteurizer

Pasteurizer Designs:
Continuous Flow

- Flash or High Temperature/Short Time (HTST)
- 161.6 ^{o}F (72 ^{o}C) x 15 seconds
- 1 to 40 gallons per minute
- Automated heat & cool cycle
- +/- Automated CIP wash system
- Cost: $20,000 - $40,000+

CalfStar, Inc.

Goodnature Products, Inc.

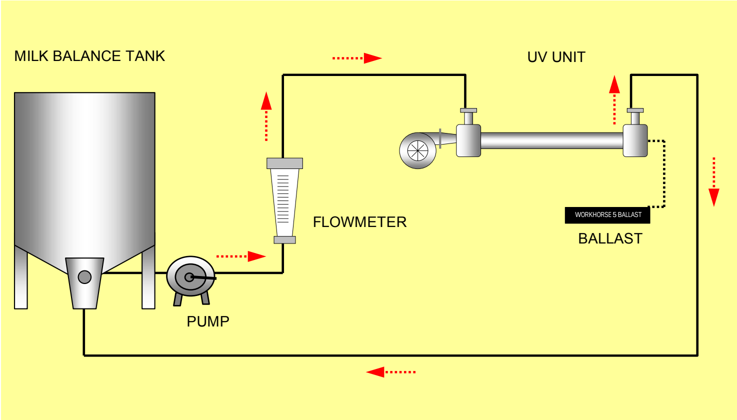
Pasteurizer Designs:
Ultraviolet Radiation

GEA Farm Technologies,
WestfaliaSurge, Inc.

- UV light passed through column of milk (200 to 280 nm = germicidal range)
- 50, 100 or 150 gallon batches
- 1.5 – 2 hours/batch
- Cost: $18,000 - $20,000
- Concern that opaque/turbid liquids attenuate and scatter UV radiation resulting in less microbial inactivation

(Viljoen and Lourens-Hattingh, 2002)

- Research suggests poorer efficacy in killing bacteria



From: Centre for Dairy Research,
Madison, WI

1: Reduced Pathogen Transmission (vs raw milk)

Does Pasteurization Kill Pathogens in Milk and Colostrum?

Pathogen	Batch (145°F, 30 min)	HTST (161°F, 15 sec)	UV
Salmonella spp.	Yes	Yes	NAv
Listeria monocytogenes	Yes	Yes	NAv
E. coli	Yes	Yes	Low-Mod
Staph. aureus	Yes	Yes	Low-Mod
M. bovis, M. californicum	Yes	Yes	NAv
Crypto. parvum	NAv	Yes	NAv
Bovine Leukemia Virus	Yes	Yes	NAv
M. paratuberculosis	Yes	Mostly*	Poor

Mycoplasma bovis: Before and after batch pasteurization

1: Reduced Pathogen Transmission (vs raw milk)

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Staph. aureus	Yes	Yes	Low-Mod
M. bovis, M. californicum	Yes	Yes	NAv
Crypto. parvum	NAv	Yes	NAv
Bovine Leukemia Virus	Yes	Yes	NAv
M. paratuberculosis	Yes	Mostly*	Poor

* Some studies saw regrowth if inoculate MAP at higher concentrations

1: Reduced Pathogen Transmission (vs raw milk)

Does Pasteurization Kill Pathogens in Milk and Colostrum?

Pathogen	Batch (145°F, 30 min)	HTST (161°F, 15 sec)	UV
Salmonella spp.	Yes	Yes	NAv
Listeria monocytogenes	Yes	Yes	NAv
E. coli	Yes	Yes	Moderate
Staph. aureus	Yes	Yes	Moderate
M. bovis, M. californicum	Yes	Yes	NAv
Crypto. parvum	NAv	Yes	NAv
Bovine Leukemia Virus	Yes	Yes	NAv
M. paratuberculosis	Yes	Mostly*	Poor

Summary of UV Research to date…

- UV treatment of milk:
  - Intermediate ability to inactivate ‘regular’ bugs (e.g. *E. coli*, *S. aureus*, Environmental Strep. spp.)
  - Poorer efficacy vs heat-based pasteurization methods:
    - UV: 3.3 log reduction
    - HTST: 5.2 log reduction (Bicalho et al., 2013)
  - Poor ability to inactive MAP (Johne’s)
- UV treatment of colostrum:
  - 43-50% denaturation of IgG

(Reinemann et al., 2006; Altic et al., App Env Micro.2007.73:3728; Donaghy et al.,2009. Bicalho et al., 2013; Pereira et al., 2014; Gelsinger et al., 2014)

‘Chemical' pasteurization?

- Don’t count on it.
- Pasteurization is defined by the PMO as heating milk to a specific temperature for a specific period of time
- Acidified milk
  - pH: 4.0 – 4.5
  - Is a PRESERVATIVE
  - Is NOT pasteurization
  - Formic acid is illegal in U.S.; Citric acid OK in U.S.
  - MAP (Johne’s) can survive at least 48 hrs at pH of 3.5

(Mutharia and Raymond (U of G), 2007)

- Other chemicals (e.g. Hydrogen peroxide)?
  - Frequently illegal and/or no safety data and/or no efficacy data

Potential benefits from feeding pasteurized milk

As compared to feeding raw milk:

- Improved health & growth by reduced pathogen exposure

As compared to feeding conventional milk replacer (CMR; e.g. 20:20 or 22:20):

- Improved rate of gain
- Improved calf health
- Improved economic efficiency

Utilization of non-saleable product (disposal issue)

CA Study: Pasteurized vs Raw Milk & Colostrum

- 300 CA calves fed either:
  a) Pasteurized colostrum and non-saleable milk (n=150)
  b) Raw colostrum and non-saleable milk (n=150)
- Benefits include higher weight gain, lower mortality, fewer days affected with diarrhea and pneumonia
- Calves fed pasteurized milk were worth an extra **$8.13** in gross margin/calf (vs calves fed raw milk)
- Est. economically feasible at 315 calves per day

Jamaluddin et al. 1996. JAVMA. 209(4):751-756

2. Improved Rate of Gain vs Conventional Milk Replacer

Predicted Daily Gain for 100 lb Calf at 68°F Ambient Temperature

(2001 NRC)

	Milk Replacer (20:20)	Whole Milk (25:29)
Feeding Rate	1 lb DM/d	4 quarts/d
Predicted ADG	0.38 lb/d	0.78 lb/d

- Fed at traditional rates, calves fed whole milk should grow better due to increased energy and protein intake (vs CMR).
- If match nutrients in milk replacer vs whole milk: Results depend on quality of milk replacer (Lee et al., 2009. J. Anim. Sci. 87:1129-1137)

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2. Improved Rate of Gain

MN Field Study: Pasteurized Milk vs 20:20 Milk Replacer

Godden et al. 2005. JAVMA. 226:1547-1554

- 439 calves enrolled from 2 dairies:
  - Dec., 2001 to Aug., 2002
- Treatment Groups:
  - Batch pasteurized non-saleable milk from Johne's infected dairy (10-12% seroprevalence) (DairyTech, Inc. Windsor, CO)
  - 20:20 milk replacer
- Facilities: two greenhouse barns

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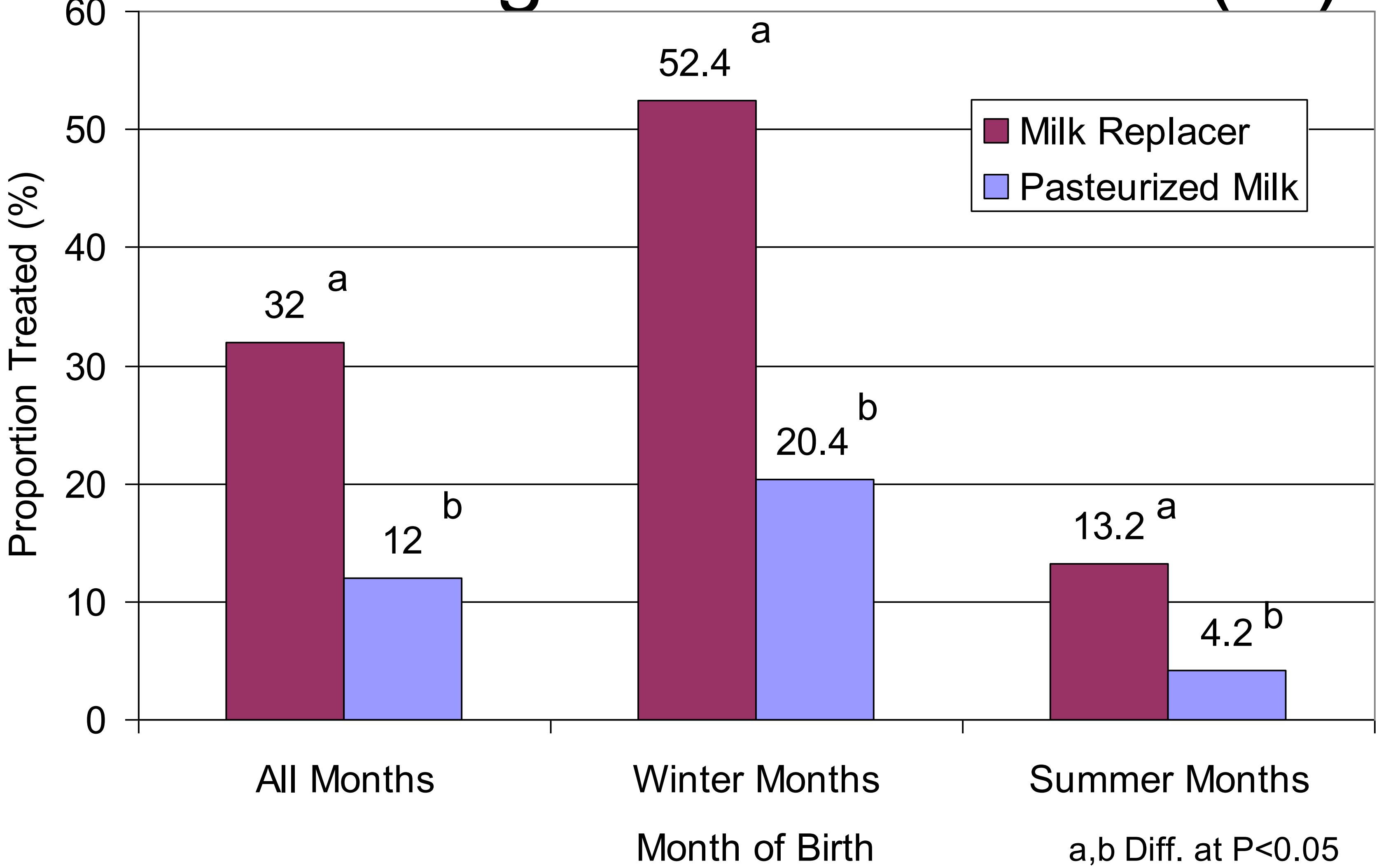
2. Improved Rate of Gain

MN Field Study: Pasteurized Milk vs 20:20 Milk Replacer

Parameter	Milk Replacer	Pasteurized Milk	P value < 0.05
Calves enrolled (n)	217	222	
Serum Total Protein (mg/dl)	5.7	5.8	
Arrival Weight (lb)	88.3	87.5	
Age at Weaning (d)	47	46	
Weaning Weight (lb)	133.9	146.3	*
Preweaning Gain (lb)	45.0	58.9	*
Avg. Daily Gain (lb/d)	0.76	1.04	*

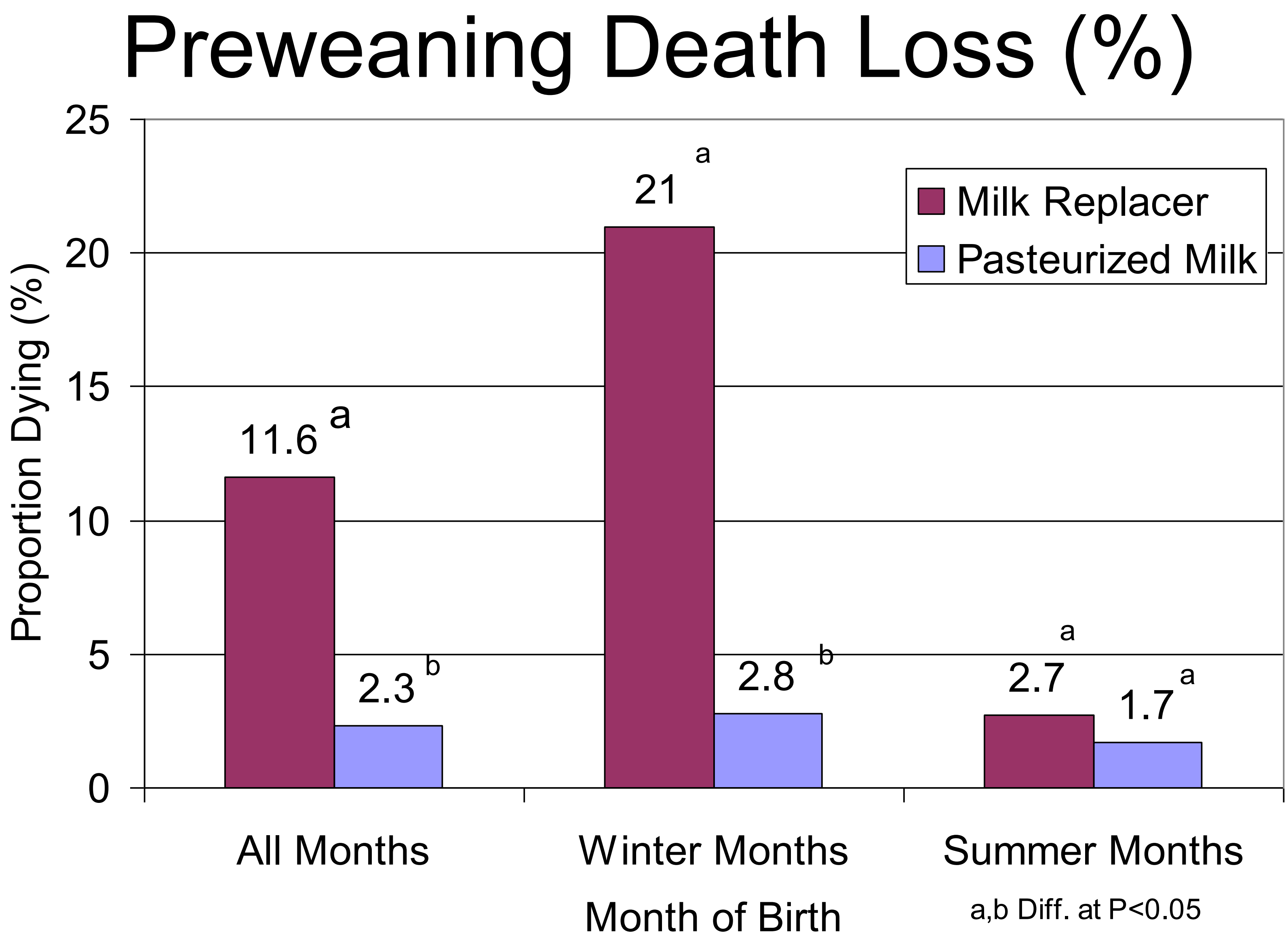
3. Improved Calf Health – Minnesota Field Study

Preweaning Treatment Rate (%)



Significant reduction in scours and pneumonia for all months

3. Improved Calf Health – Minnesota Field Study



Significant reduction in death losses in winter months

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4. Improved Economic Efficiency

MN Field Study: Pasteurized Milk vs 20:20 Milk Replacer

- Results
  - Relative cost advantage of pasteurized non-saleable milk system:
    - $0.69 per calf per day
    - **$34 per calf weaned**
  - Breakeven analysis:
    - **23 calves fed/day**
- **www.cvm.umn.edu/dairy/software/listing**
- Followed to avg 57 months of age to measure impact on Johne’s disease, longevity and performance

Adult Cow Performance

- From 1st calving to avg. 57 months

(Linear or Logistic regression, herd = random effect)

	Milk Replacer	Pasteurized Milk	P Value
Cows w first calving event	54	65	
Milk yield (lact > 150 DIM)			
Sum Lact 1 & 2 (kg)	22,028	23,964 (+1,935)	0.084
% culled or died	53.7%	41.5%	0.036
% MAP positive	27.8%	21.5%	0.36

Differences significant if $P < 0.05$

Summary of potential benefits from feeding pasteurized milk

1. As compared to raw milk:…
   a) Improved health and growth by reducing pathogen transmission
2. As compared to a conventional milk replacer:
   a) Improved rate of gain
   b) Improved calf health
   c) Improved longevity and future performance
   d) Improved economic efficiency
3. Utilization of non-saleable product (disposal issue)

Making the system work for you:
Avoiding the pitfalls

1. Need for more intensive management
2. Avoid pasteurization failure by managing entire system correctly
3. Avoid inconsistent nutrient composition
4. Develop strategy for inadequate milk supply
5. Monitoring
6. Concerns about antimicrobial residues

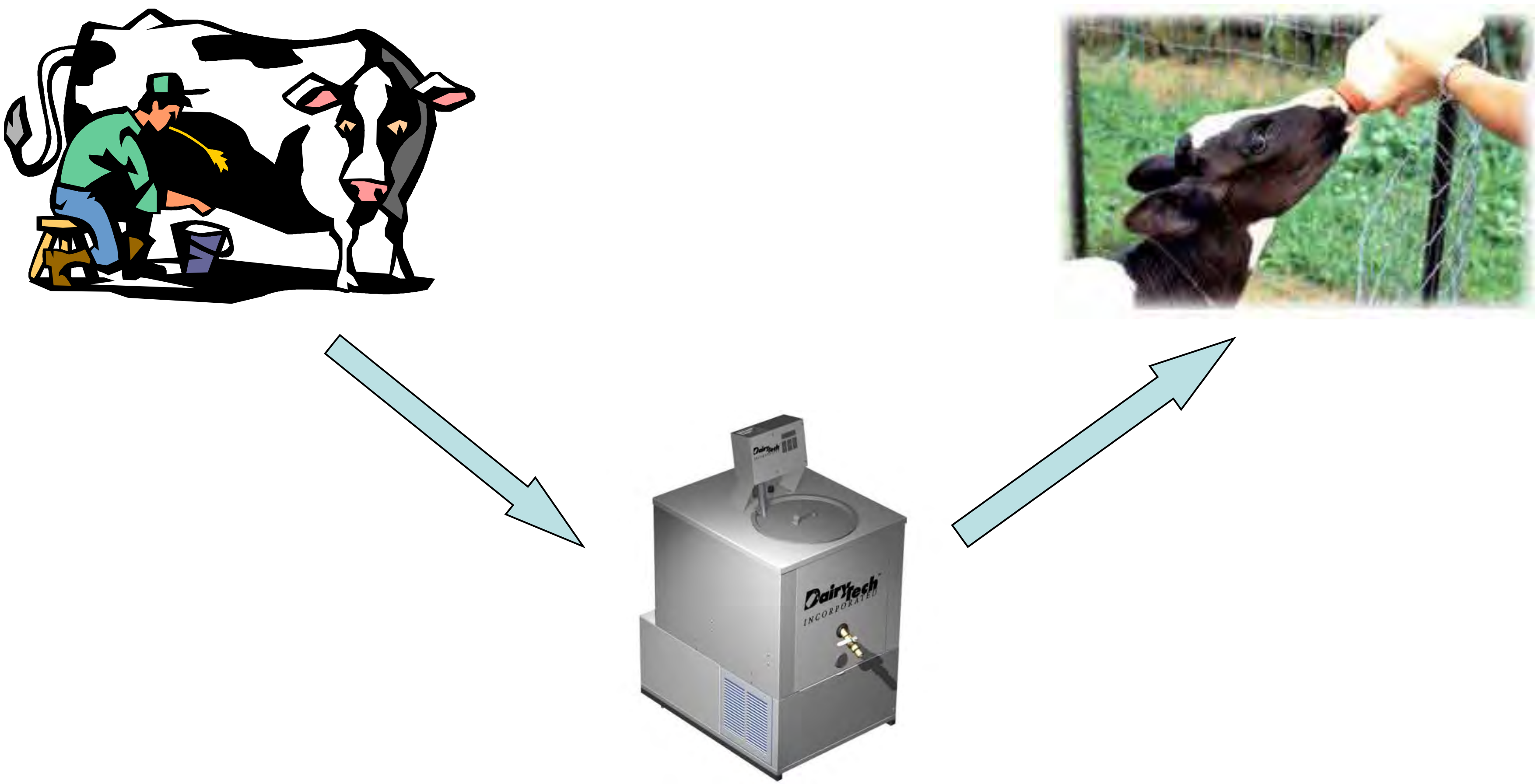
1. Need for more Intensive Management

Planning and Managing Pasteurized Milk Feeding Systems

- Planning and Installation:
  - Housing / location of equipment
  - Water, electrical & drainage supply
  - Installation (support?)
  - Develop system to collect, store and transport raw and pasteurized milk
- Operation:
  - Training
  - Protocols for handling raw and pasteurized milk
  - Pasteurization protocols
  - Cleaning protocols
  - Monitoring protocols
  - Service support

2. Risk of Pasteurization Failure

Risk of Pasteurization Failure if <u>SYSTEM</u> Not Managed Correctly



Risk of Pasteurization Failure if <u>SYSTEM</u> Not Managed Correctly

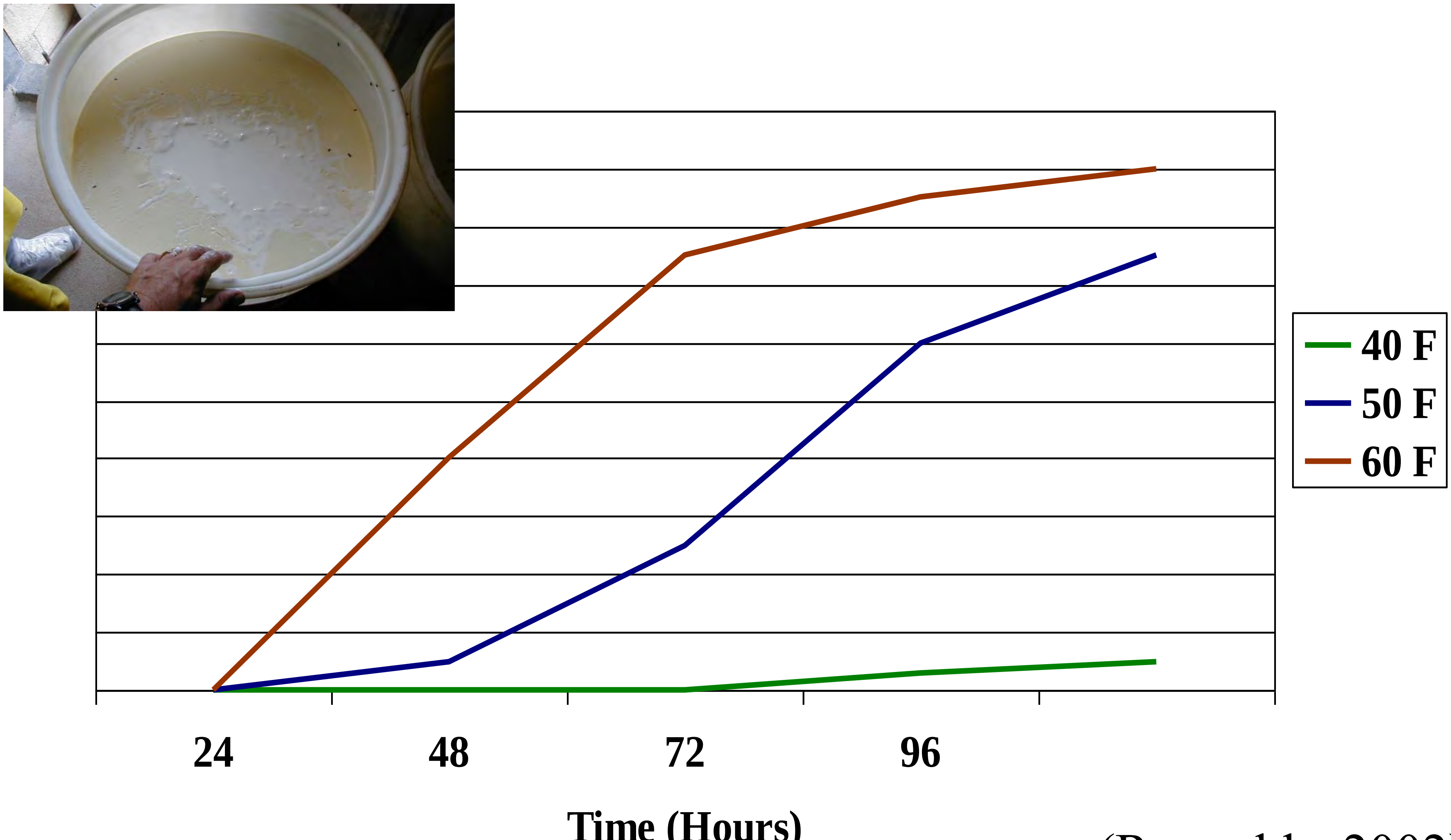
Avoid contamination during harvest & transfer of raw milk

2. Risk of Pasteurization Failure

Risk of Pasteurization Failure if <u>SYSTEM</u> Not Managed Correctly

How is raw milk handled on the way to the pasteurizer?

Problem: Excessive Bacterial Growth in Improperly Stored Raw Milk



(Reynolds, 2002)

One Cause of Pasteurization Failure:

Start with too many bugs!

- Improper storage of raw milk:
  - Bacteria multiply quickly at warm temps
  - Unchilled milk: > 1 billion CFU/ml in summer
- Pasteurization does NOT equal sterilization
  - If pasteurizer removes 99% of bacteria:

Pre	Post	
50,000	500	(cfu/ml)
1 billion	10 million	(cfu/ml)

Do NOT pasteurize soured (spoiled) milk

- Fermentation of non-chilled milk
- Acid production (pH < 4.7)

- Add heat

- Curd formation

2. Risk of Pasteurization Failure

Risk of Pasteurization Failure if <u>SYSTEM</u> Not Managed Correctly

Avoid bacterial proliferation in raw milk:
- Pasteurize within 2 hrs
  or
- Rapidly chill raw milk

2. Risk of Pasteurization Failure

Risk of Pasteurization Failure if <u>SYSTEM</u> Not Managed Correctly

Does the pasteurizer work?

2. Risk of Pasteurization Failure

Risk of Pasteurization Failure if <u>SYSTEM</u> Not Managed Correctly

Monitor:
- -Times & temps
- - Rapidly cool
- - Cleaning
- - Bacteria counts

2. Risk of Pasteurization Failure

Risk of Pasteurization Failure if <u>SYSTEM</u> Not Managed Correctly

How is milk handled
on the way to the calf?
- Avoid recontamination

Recontaminating Pasteurized Milk: A Weak Link

(J. Heinrichs and C. Jones. Hoard's Dairyman. 07/2011 pg. 442)

- 6 Pennsylvania farms
- 129 matched milk samples:
  pre-, post-pasteurized, calf bucket

SPC (cfu/ml)	mean	range
Pre-pasteurization	64,712	240 to 658,000
Post-pasteurization	5,877	0 to 250,000
Calf bucket	30,443	0 to 250,000

Avoid Post-Pasteurization Contamination

- Keep pasteurized milk in clean covered containers
- Feed shortly after pasteurization or else rechill milk until feeding time
- Sanitation of transfer hoses, storage tanks, bottles, buckets and nipples
- Monitor bacteria counts

2. Risk of Pasteurization Failure

Risk of Pasteurization Failure if SYSTEM Not Managed Correctly

Avoid recontamination
- Feed ASAP or rechill
- Sanitation of storage, transport & feeding equipment

2. Risk of Pasteurization Failure

Risk of Pasteurization Failure if <u>SYSTEM</u> Not Managed Correctly

Avoid contamination during harvest & transfer of raw milk

Avoid bacterial proliferation in raw milk:
- Pasteurize within 2 hrs
  or
- Chill

Monitor:
-Times & temps
- Rapidly cool
- Cleaning
- Bacteria counts

- Avoid recontamination

3. Avoiding Inconsistent Nutrient Composition

Avoiding inconsistent nutrient composition of non-saleable milk?

- James et al., 2006
  - Study of 3 NC farms and 10 CA farms
  - Most samples had > 29% fat and 26% protein (DM basis)
  - Some samples had < 1.5% fat (norm = 3.8%) (as fed basis)

- To minimize variation in nutrient content:
  - Avoid flushing lines with too much water at end of milking
  - Agitate milk well prior to pasteurization and again, prior to feeding calves

Brix Refractometer to Monitor Total Solids in Milk

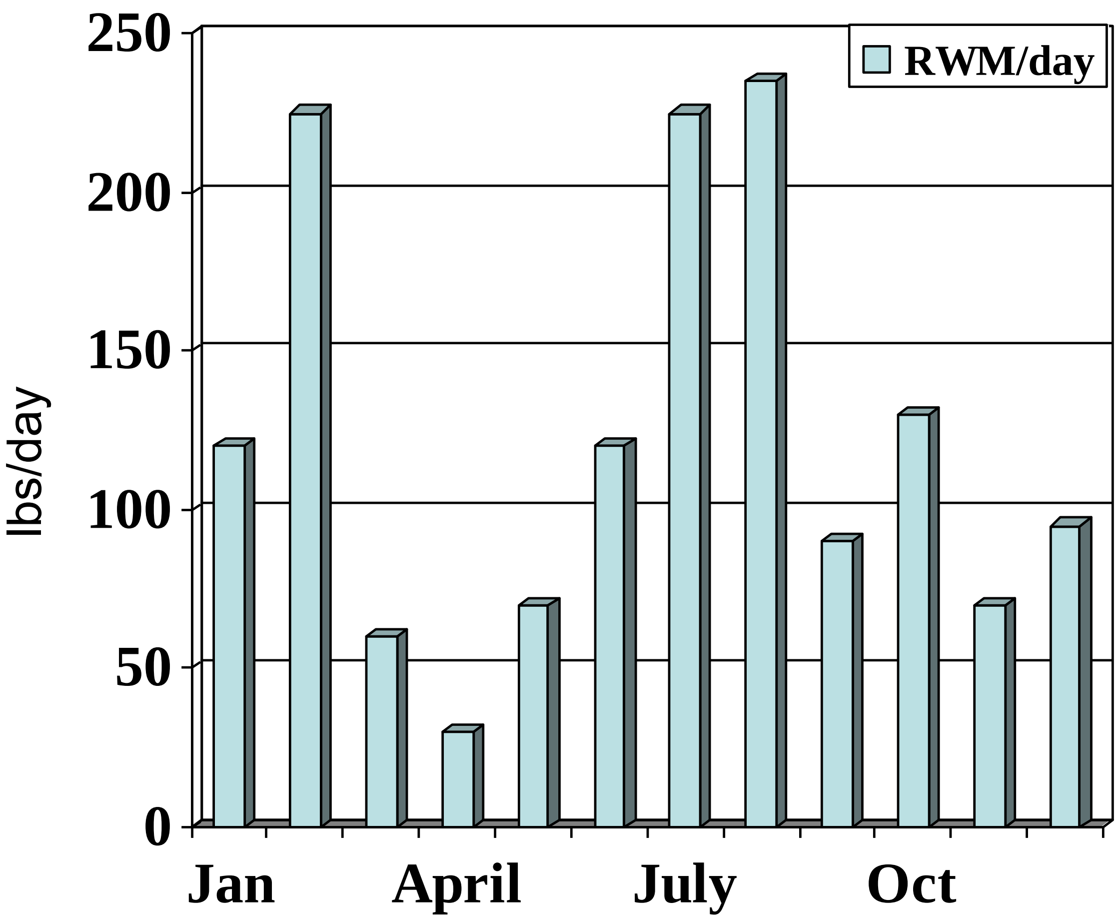
(Moore et al., 2009. J. Dairy Sci. 92:3503)

- Instrument:
  - Reichert Inc. (Depew, NY), $270
  - Capable of measuring TS in milk ranging between 5 – 15%
  - Instrument reads 2% points low (vs spectrophotometry)
    - Adjust Brix reading 2% points higher to estimate TS
- Evaluation of whole milk samples from 12 CA dairies:
  - Adjusted Brix TS readings: 5.1 to 13.4% (< 12 TS % in 6 of 12)
- If low TS results:
  - Fix the system at the source
  - Add milk replacer powder to increase TS

http://www.das.psu.edu/research-extension/dairy/nutrition
for pasteurizer evaluator spreadsheet

4. Inconsistent milk supply

Need strategy for inadequate milk supply



Discard Milk From Waseca Dairy Herd, 2001

Options:

1. Add salable bulk tank milk
2. Add milk from high SCC cows
3. Extend with high quality milk replacer (e.g. 28:20)
4. Feed younger calves milk, older calves milk replacer.

5. Monitoring

Options for Monitoring the Pasteurized Milk Feeding System

(Producer factsheet at UMN Udder Health Lab website)

- Pasteurizer function:
  - Times and temperatures – daily
  - Periodic Alkaline Phosphatase test
    - < 500 mU/ml
- Quality of Raw and Pasteurized Milk:
  - Culture of milk samples (weekly or monthly) (Cullor, 2003):
    - Raw milk: < 1,000,000 CFU/ml TPC
    - Pasteurized milk: < 20,000 CFU/ml TPC
  - Total solids content of milk
    - whole milk 12.5% solids
    - 10-12% using Brix refractometer
  - pH (normal milk is 6.7. Expect trouble if < 5.0)

Field Studies of Pasteurization Systems

- Pasteurizer function:
  - Jorgenson and Hoffman, 2005; James, 2006:
    - WI study of 31 on-farm systems: 88% passed Alk Phos test
    - 3 NC farms: 100%, 85%, 82% of samples passed Alk Phos
- Milk quality:
  - Moore et al., 2009. JDSci 92:3503:
    - 12 CA dairies:
      - pH: avg = 6 (4.7 to 6.6) *(expect 6.5 - 6.7)*
      - Adjusted TS avg = 11% (5.1 to 13.4%) *(expect ≥ 12.5%)*
  - Elizondo-Salazar et al., 2010. JDSci 93:5509:
    - 6 PA herds:
      - Pasteurizer did excellent job but many recontaminated samples
- Message: **NEED TO MONITOR!!!**

Other Questions:

- How high can we go?
  - Hotter is NOT always better!

    > 175 °F (80 °C) can result in:
    - calcium and phosphorus precipitates
      => deposits interfere with heat exchange and cleaning
    - Protein denaturation and decreased fat availability
      => poor calf performance

- Take home messages:
  - Stay at or close to PMO temperature guidelines
  - Importance of agitator in batch pasteurizers => even mixing and heating
  - Do not repasteurize milk

Other Questions:

Concerns about antibiotic residues?

- Pasteurization does not inactivate most antibiotics in milk
- Concerns:
  - Violative residues in meat (bob veal/veal)
  - Concern could lead to development of antimicrobial resistance in enteric pathogens => public health concern
  - Public scrutiny and research will continue
  - VFD: Implications for feeding treated milk???

Pasteurized Milk Feeding Systems: Summary

- Potential Advantages:
  - Reduce pathogen transmission
  - Improved rate of gain
  - Improved calf health and future performance
  - Improved economic efficiency
  - Utilization of non-saleable product (disposal issue)

- Avoiding the pitfalls
  - Need for more intensive management
  - Avoid pasteurization failure by managing entire system correctly
  - Avoid inconsistent nutrient composition
  - Develop strategy for inadequate milk supply
  - Monitoring

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Thank you!