Building the Foundation

2010 Dairy and Veal **Healthy Calf** Conference

Organized by:

Nutritious Ontario Veal Delicious

Sponsored by:

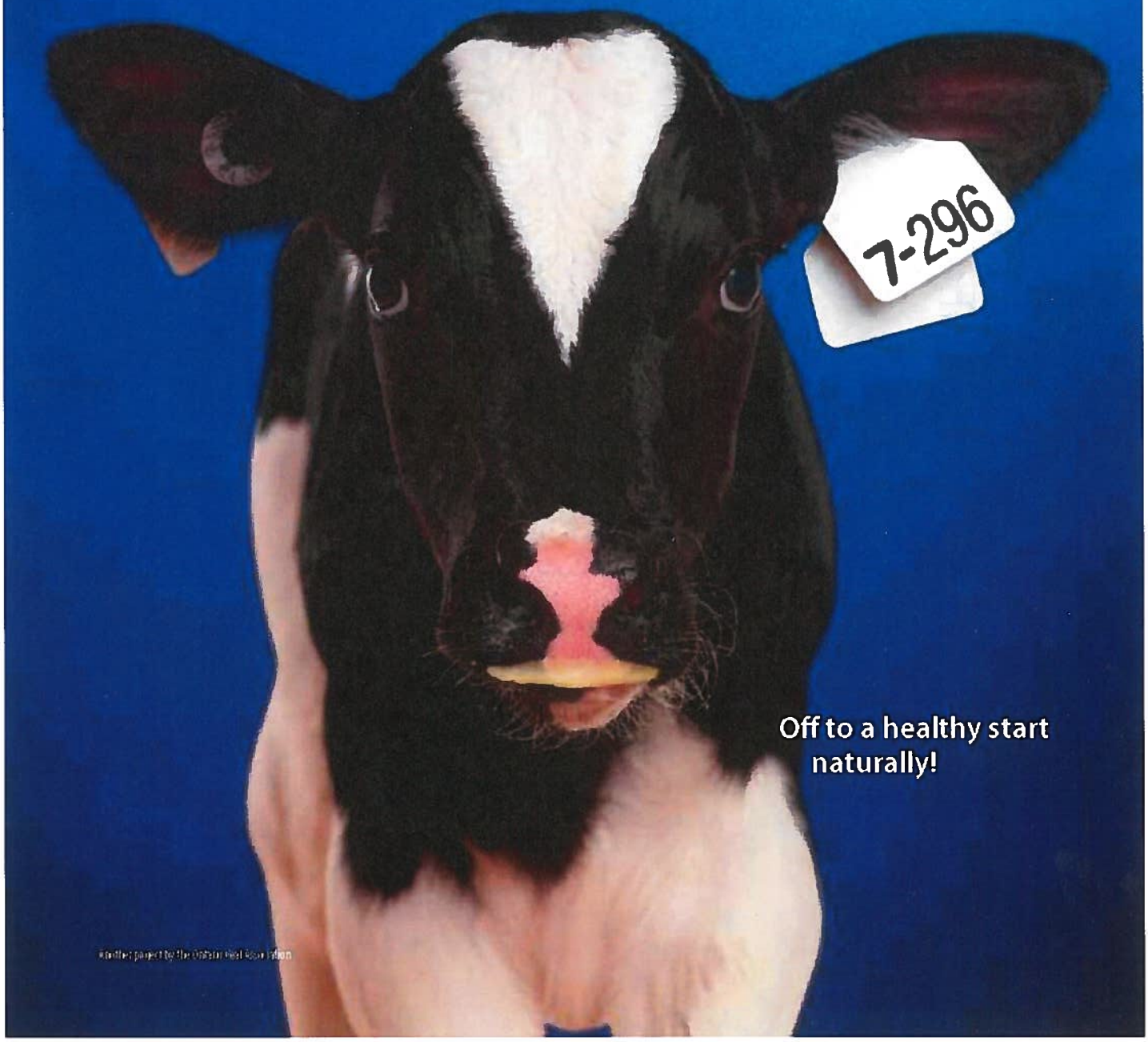
GROBER NUTRITION

Milk
Dairy Farmers Of Ontario

got colostrum?

It's no secret — feeding 4 litres of good quality colostrum within 30 minutes of birth can have a dramatic and lifelong impact on calf health. Feeding colostrum to all your calves can boost their immunity the way Mother Nature intended. Colostrum has been proven to reduce death loss and improve calf health simply by building a solid foundation. It may take a little bit of effort but it's money in your pocket at the end of the day!

www.calfcare.ca



Off to a healthy start naturally!

Building the Foundation

Dairy and Veal Healthy Calf Conference 2010

WELCOME

Dear Conference Participants,

Raising calves can be challenging for both dairy and veal producers. Calf mortality and morbidity translates to high financial losses in both the dairy and veal industries. Fortunately there are tools to help us manage these challenges.

The Ontario Veal Association is pleased to once again organize and present the fourth biennial *Building the Foundation: Dairy and Veal Healthy Calf Conference*. This conference aims to provide both dairy and veal farmers with practical information they can implement on their farms to improve calf health and quality. Both the veal and dairy industries are working towards the same goal; improving the quality of all of our calves.

This year's conference brings together an exceptional line-up of guest speakers. Dairy and veal producers alike can learn practical, hands on tips for raising strong healthy calves. From colostrum to shipping regulations to nutrition and management, we have a wide variety of topics that every veal and dairy producer should know about. Thank you to our speakers for joining us today and sharing your insight and experience.

A special thank you to all of our industry partners who have graciously provided sponsorship and support for this important educational event. I hope that you will be able to speak with the many representatives in attendance today to help find solutions for your operation.

On behalf of the Ontario Veal Association, I welcome you to the fourth biennial Healthy Calf Conference.

Sincerely,

Judy

OVA President

For more information on the Ontario Veal Association or to become a member contact the OVA office at 519-824-2942.

Nutritious Ontario Veal Delicious

Building the Foundation

Dairy and Veal Healthy Calf Conference 2010

AGENDA

December 8th, 2010
Stratford Rotary Complex

8:30 am	**Registration and Tradeshow Open**
9:00 am	**Welcome and Opening remarks**
9:15 am	**What Are The Benefits of Functional Proteins To A Calf's Immune System?** *Dr. Jim Quigley, Author of Calf Notes.com*
10:15 am	**The 5 Q's of Colostrum Management: So What is New?** *Dr. Sandra Godden, University of Minnesota*
11:15 am	**Calf Management Update: What Does it Mean For Your Farm?** *Dr. Ken Leslie and Team, University of Guelph*
11:45 am	**Ontario Veal Luncheon & Tradeshow**
1:15 am	**Calf Feeding Trial Results from the Young Animal Development Centre** *Kathleen Shore, Grober Nutrition*
1:40 pm	**Management Practices That Result in Healthier Calves?** *Brian Keunen, Ontario Veal Producer*
2:00 pm	**Putting Calf Nutrition to Work** *Dr. Drew Vermeire, Nouriche Nutrition Ltd*
3:00 pm	**Shipping Your Calves Off The Farm: The Do's and Don'ts** *Mike Draper, OMAFRA*
3:30 pm	**Wrap Up and Adjourn**

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Milk

DAIRY FARMERS OF ONTARIO

Beyond Nutrition

Proteiva™
Functional Proteins

Optimize calf performance now and in the future with **Proteiva™ Functional Proteins** technology.

NutraPro P spray dried plasma enhances the nutritional value of calf milk replacers by offering functional proteins during a critical growth phase. Ask your feed company to add NutraPro P to your calf milk replacer.

NutraPro
Functional Protein Additive

For more information:
800-513-8755 / 515-289-7600
www.proteiva.com
www.functionalproteins.com

Technology by APC
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CONFERENCE SPONSORS

Title

Ontario Veal Association

Platinum

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Other

Canada's Outdoor Farm Show
Gencor

Thank you to our sponsors for their ongoing support of this important educational and industry event.

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Dairy and Veal Healthy Calf Conference 2010

TRADESHOW EXHIBITORS

Agri Plastics

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Thank you to all our industry partners for your continued support of the Healthy Calf Conference!

young animal SPECIALISTS

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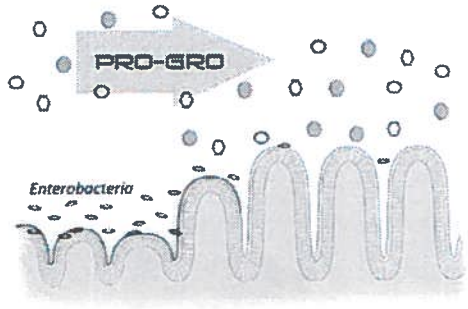
HIGH PERFORMANCE & EXCEL

Milk Replacers now contain PRO-GRO

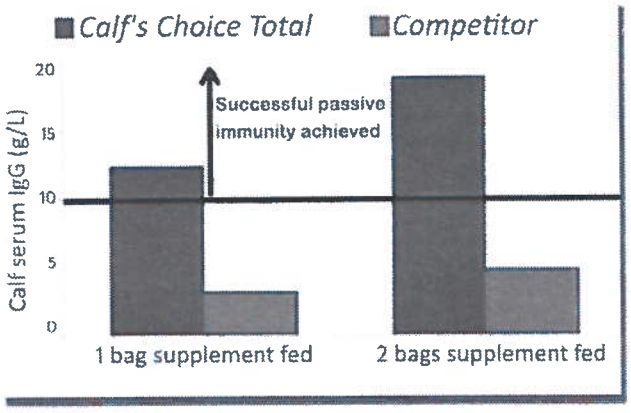


- Encourage strong health and optimal growth
- Shown to have a positive effect on overall gut health
- Helps young animals develop a strong immune system

CALF'S CHOICE TOTAL®

The Biggest & The Best

A premium colostrum supplement that prevents
Failure of Passive Transfer (FPT)
of immunity from cows to their calves.



Grober Nutrition 800-265-7863 x210 www.GROBERNUTRITION.com

What Are The Benefits of Functional Proteins To A Calf's Immune System?

Dr. Quigley received his Ph.D. from Virginia Tech in 1985 and B.S. and M.S. degrees from the University of New Hampshire. His research has focused on dairy calf nutrition, health and management. Jim has published over 200 refereed journal articles and abstracts related to the nutrition and health of young calves and heifers. He has spoken throughout the world on calf management subjects and has won several awards from scientific societies for his research contributions.

Dr. Quigley was previously with APC from 1998 to 2004 and served in several positions, including Vice President of Research. He was V.P. for Research & Technical Service at Diamond V Mills in Cedar Rapids, Iowa, Associate Professor of Animal Science at the University of Tennessee and Dairy Nutritionist at Cargill, Inc., Elk River, Minnesota. Jim also serves as Adjunct Professor at Iowa State University in Ames, Iowa.

Jim is an accomplished runner and has completed more than 20 marathons. He and his wife Cynthia live in Johnston, Iowa with their two children, Jay and Eric.

Dr. James D. Quigley, III, Ph.D., PAS
Vice President and Director, Calf Operations
APC, Inc.

Dr. Quigley is vice President and Director, Calf Operations at APC, Inc., in Ankeny IA. He is responsible for all aspects of APC's calf business worldwide, including sales, marketing, technical service, research, and new product development.

Dr. Quigley also maintains the website CalfNotes.com, which is recognized internationally as a source of information related to calf management.

Building the Foundation

Dairy and Veal Healthy Calf Conference **2010**

Functional proteins for calf health & nutrition

Proteiva

Dr. Jim Quigley, Ph.D., PAS, Diplomate, ACAN
V.P. and Director of Calf Operations
APC, Inc.
Ankeny, IA 50021 USA

APC

Calf health…

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…is elusive

- We lose too many calves prior to weaning
- Dairy '07 survey by USDA NAHMS reported that nearly 22% of calves don't reach weaning

Neonatal calf mortality in the U.S.

Year	Birth*	Prewean**	Total
1996	6.6	10.8	17.4
2002	11.2	10.5	21.7
2007	14.0	7.8	21.8

NAHMS surveys of dairy operations in the U.S. in 1996, 2002, and 2007
*Calves born dead or not alive at 48 hr
**Calves not alive at weaning (avg. 8 wk)

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...and affects productivity

- Each calf is born with a fixed genetic potential
- Nutrition & management affects its ability to express that genetic potential for milk production

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Neonatal calf health

- Depending on the farm, primary health issues related to scours or respiratory infections
- USDA estimated that >50% of treatments prior to weaning are due to diarrhea

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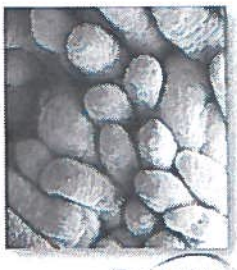
The gut

- Intestinal epithelial cells are the site of nutrient absorption
- Constantly bombarded with pathogens, anti-nutritional factors, etc.
- Gut is site of neonatal infections causing diarrhea



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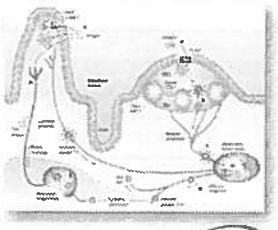
Defensive mechanisms

- Numerous defensive mechanisms protect the gut
  - pH
  - Digestive enzymes
  - Mucin
  - Antibodies
  - Bacteria (probiotic)
  - Peyer's Patches, Dendritic cells



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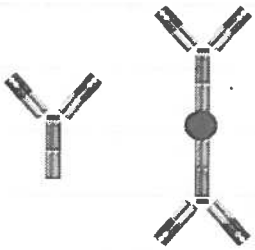
Antibodies in the lumen

- Research shows that antibodies (immunoglobulins) play an important role in intestinal defense
- IgA
- IgG



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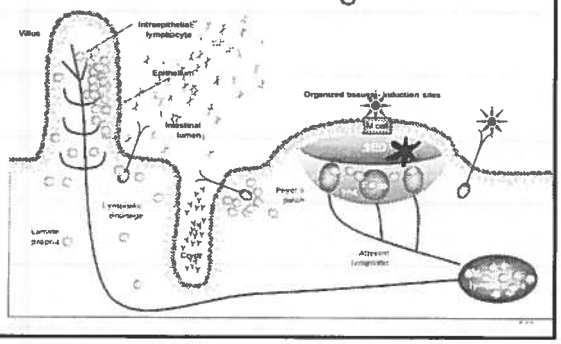
Intestinal immunoglobulin



Intestinal IgG research

- Besser et al. (1988) injected newborn calves with ^{125}I labeled IgG
- Monitored fecal excretion of IgG
- Collected IgG in lumen by necropsy
- Calves absorbing 100 g of IgG would secrete 1-4 g of IgG per day back into the intestine

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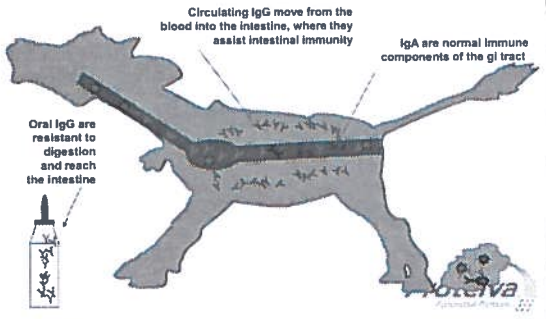
Effect of IgG (functional protein)



Sources of antibodies

- All are animal proteins
  - Colostrum & milk
  - Eggs
  - Plasma
- Polyclonal / monoclonal
- Keys are
  - availability
  - cost
  - specificity
  - activity

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Colostral IgG

- Colostrum contain IgG, IgM and IgA
- Ig concentration declines with advancing lactation
- 25 g of IgG/L x 100 ml = 2.5 g of IgG/day
- Ig is the reason to recommend feeding calves 3 d after birth

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Colostral IgG

- 31 Holstein bull calves <8 hr of age
- Treatment
  - Control milk replacer (MR) - no challenge
  - MR + rotavirus challenge
  - MR + 118 ml colostrum + challenge
  - MR + 473 ml colostrum + challenge
- Colostrum obtained from cows immunized with a USDA licensed rotavirus vaccine

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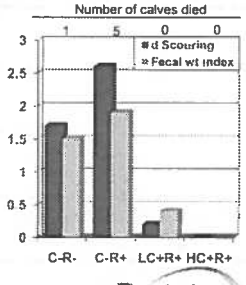
Colostral IgG

- Calves were colostrum deprived
- Calves were fed non-medicated CMR with or without MC 2x/d
- Calves were challenged after 1st feeding
- Range of IgG intake - 7 to 66 g/d



Fowler et al., 1994. J. Dairy Sci. 78(Suppl. 1) 235 (Abstr.)

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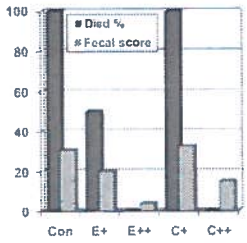
IgY from eggs

- Hyperimmunize birds against a specific pathogen (e.g., rotavirus)
- IgY is produced in blood, then transferred to egg
- Egg yolk is dried to produce a powder containing specific IgY
- Lower amounts of Ig than others, but specific (monoclonal)

Proteiva

IgY from eggs

- Eggs and MC collected after challenge with coronavirus @ 2 titers
- 23 calves fed
  - CMR (Con),
  - CMR + egg, low, high
  - CMR + MC, low, high
- Challenged with coronavirus on d 0



Ikemori et al., 1997

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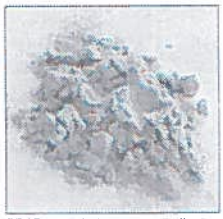
IgG from plasma

- Animal plasma is the product obtained by spray drying plasma which has been separated away from the cellular material (red and white blood cells) of fresh whole blood by chemical and mechanical processing. The protein portion of this product is primarily albumin, globulin and fibrinogen type proteins.
  - AAFCO definition 9.72 (1993)



SDAP is a light brown, easily flowing powder that contains functional proteins, including globulin protein

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Plasma in animal agriculture

- Plasma has been used successfully in animal diets for many years
- Benefit of plasma in weanling pigs has revolutionized the weanling pig industry
- NutraPro B™ in CMR formulations will provide great benefit to calves

Proteiva

NutraPro

- Spray-dried animal plasma specifically manufactured for use in calf milk replacer (liquid) formulas
  - Light color
  - High solubility
  - Low iron
  - Excellent digestibility
  - Proteiva Functional Proteins
  - Bovine (B) or porcine (P)

Proteiva

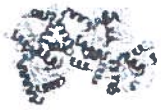
Functional proteins

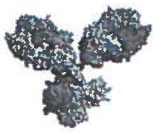
- Careful processing and drying to retain *functional proteins* are key to success of plasma as an ingredient
- Functional proteins are those that influence the animal after consumption but before digestion
  - i.e., they *do something* inside the animal

Proteiva

IgG vs. functional proteins

- IgG is only one type of functional protein
- Eggs, colostrum and plasma all contain unique categories of non-IgG FP
  - IgA, IgM
  - Lactoferrin, transferrin, α-2 macroglobulin, transforming growth factor-β, others





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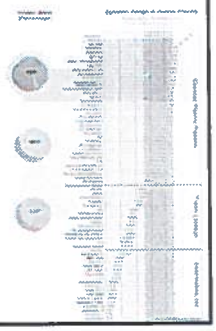
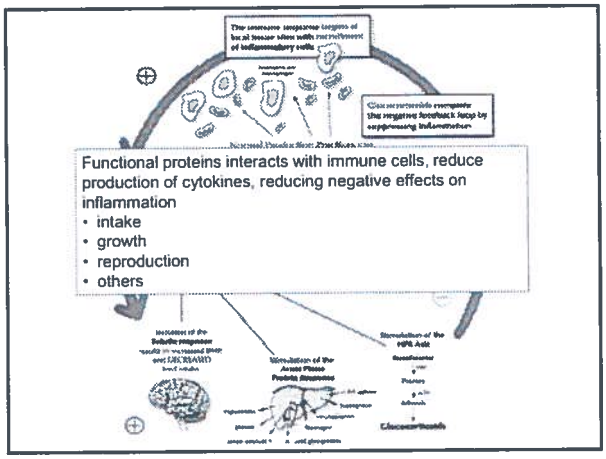
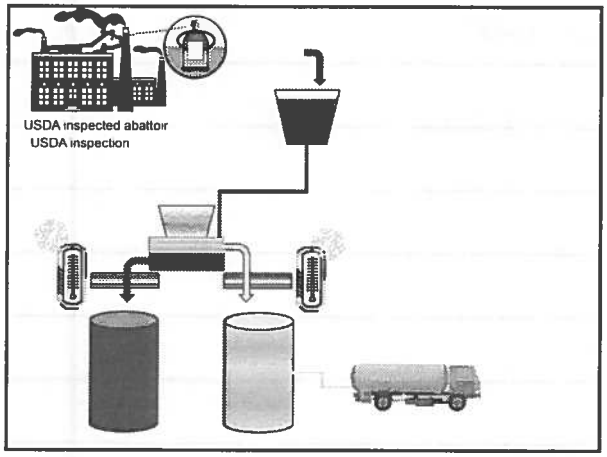
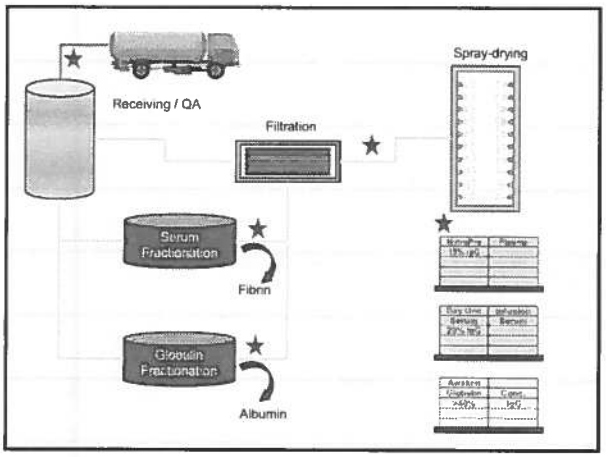
Proteins vs Functional Proteins

- Traditional use: nutritional source of amino acids for the animal
- Research shows some proteins have biological actions beyond nutrition for the animal - **functional proteins**
- **Functional proteins** are a tool that may influence the animal's performance and affect health

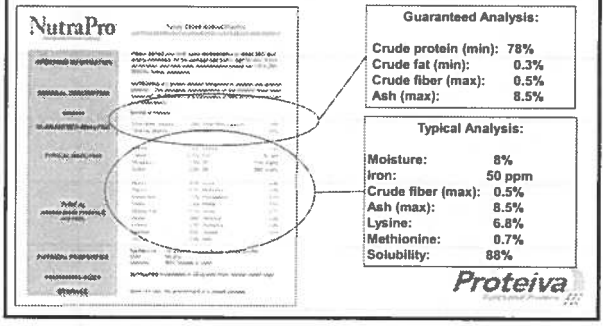








NutraPro B composition



Guaranteed Analysis:

Crude protein (min):	78%
Crude fat (min):	0.3%
Crude fiber (max):	0.5%
Ash (max):	8.5%

Typical Analysis:

Moisture:	8%
Iron:	50 ppm
Crude fiber (max):	0.5%
Ash (max):	8.5%
Lysine:	6.8%
Methionine:	0.7%
Solubility:	88%

Proteiva

NutraPro inclusion

- NutraPro will replace WPC and whey in a CMR in the ratio of 3:2
- (3 x WPC) – (2 x whey)
  - (3 x 34) – (2 x 12) = 78
- Up to 8% in formulas without affecting intake or digestion

- No change in handling, color, smell of CMR
- Flexibility in formulation

Proteiva

Why NutraPro?

- Digestibility is similar to or higher than other non-milk proteins
- Excellent amino acid profile
- No anti-nutritional factors
- Readily available
- Added bonus of "plasma effect" for calves during periods of stress

Proteiva

E. coli challenge

- 36 calves fed 2 qt (½ lb.) 2x/d for 21 d
  - Control (20% protein, 20% fat)
  - Control + 800/400 neomycin + oxytetracycline
  - Control + bovine plasma
- On d 3, calves challenged with an enteropathogenic strain of *E. coli*
- Intake, BW, ADG, fecal scores, dehydration and attitude scores

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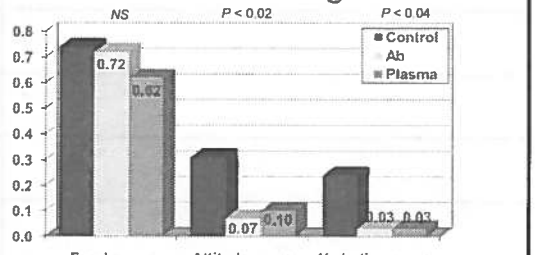
E. coli challenge



Fecal score: 0 = normal to 3 = severe
Attitude score: 0 = normal to severe depression
Hydration 0 = no skin tenting to 2 = 5-10 sec

Quigley & Drew, 2000

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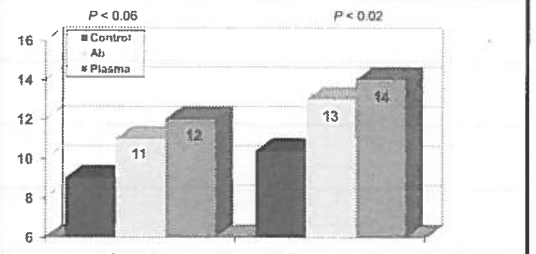
E. coli challenge



Quigley & Drew, 2000

Proteiva

High stress calves

- 120 Holstein bull calves fed 1.0 to 1.6 lb CMR/d (12 – 13% DM)
  - Control (WPC; 20% protein, 20% fat)
  - Control + 5% NutraPro B
  - Control + 5% NutraPro P
- Intake, BW, ADG, fecal scores, mortality and d treated with Ab and electrolytes

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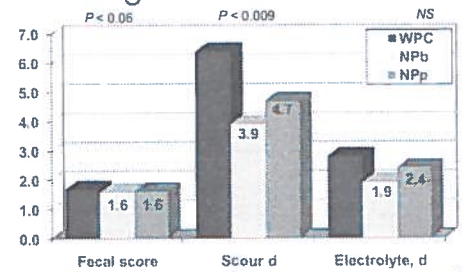
High stress calves



Fecal score: 0 = normal to 4 = severe

Quigley & Wolfe, 2003

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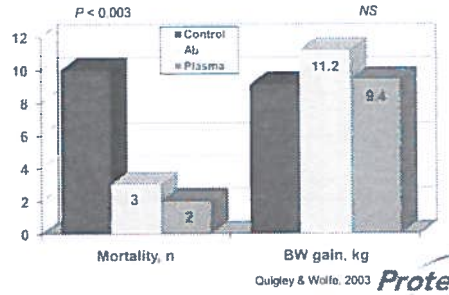
High stress calves



Quigley & Wolfe, 2003

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High stress vs. low stress

- In "higher stress" environments, the benefits of NutraPro are clearly evident – particularly related to reduced scours
- In very low stress environments, NutraPro performs similarly to WPC in CMR formulations

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NutraPro studies

Item	Control	NutraPro	% change
n	553	553	...
Days	46	46	...
ADG, lb/d	1.22	1.26	+3.3
Days treated	4.06	3.46	-14.8
% calves treated	48.2	45.0	-6.6
Mortality, %	18.0	12.5	-31

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FDA regulations on BSE

- 21 CFR Part 589.2001 – Substances Prohibited From Use in Animal Food or Feed.
- FDA specifically stated in their opinion that, "*FDA is not prohibiting the use of blood and blood products in animal feed because we believe such a prohibition would do very little to reduce the risk of BSE transmission.*"

Proteiva

On farm application

- On farm application of functional proteins depends on:
  - Quality control and activity of functional proteins
  - Cost
  - Storage
  - Inclusion rate
  - Replacement value

Proteiva

Stored colostrum

- Advantages
  - Available on dairies
  - Low cost
  - High IgG in come samples
- Disadvantages
  - Storage / contamination
  - Variable IgG
  - Management (how much to add to CMR)

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Cost of colostrum

- USD $5 for 1 gallon (3.8 L) of colostrum
- 100 ml = 5 / 38 = $0.13 per day
- Other costs
  - Storage / quality
  - Measuring
  - Monitoring IgG
  - Fermentation?

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Egg protein

Not generally labeled to contain specific antibodies
- "R + C" = rotavirus + coronavirus
- No measured titer
- Specificity of IgY against pathogens
- Shelf life?

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Cost of egg protein

- Commercially available sources = $0.10 to $0.25 per calf daily
- Other costs
  - QC?
  - Storage / mixing

Proteiva

NutraPro

- Included in CMR formulas at 5 to 8%
- Replaces WPC, whey protein
- Simple application, fed throughout milk feeding period

Proteiva

Cost of NutraPro

- Similar to current WPC, whey pricing in U.S.
- CMR containing NutraPro approximately par with all-milk
- No other costs associated with use

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Summary

- Functional proteins provide additional source of components to support intestinal immunity
- Primary sources of functional proteins are colostrum, spray-dried egg, and NutraPro (plasma)
- Each has specific advantages and disadvantages

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Summary

- Using a source of functional proteins can reduce reliance incidence and severity of diarrhea in preweaned calves
- Cost, quality control, source and availability will affect the decision of which source of functional proteins to use in CMR diets

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The 5 Q's of Colostrum Management: So What is New?

Sandra is a 1993 graduate of the Ontario Veterinary College, University of Guelph. After working for two years as an associate veterinarian in mixed practice in Eastern Ontario, she returned to Guelph to complete a three-year Doctor of Veterinary Science degree specializing in dairy production medicine.

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

From 1998 to present she has been a member of the Center for Dairy Health, Management, and Food Quality at the University of Minnesota where she is involved with student teaching, applied research and dairy outreach activities. Major academic interests include applied research in colostrum management, calf health management, Johne's Disease control, mastitis control and transition cow management.

Building the Foundation
Dairy and Veal Healthy Calf Conference 2010

The 5 Q's of Colostrum Management: So, What is New?

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

College of Veterinary Medicine

Is the Dairy Industry Succeeding with Calf Health Management?

- Preweaning mortality rates 7.8-11%
  - 53% due to scours
  - 21% due to respiratory disease
  (NAHMS 1993, 1996
- 21% of U.S. [illegible] have failure [illegible] ister [illegible] IgG < 10 mg/ml)
  (NAHMS, 2007)
- 31% of deaths in the first 3 weeks were due to FPT (Wells, 1996)

We have an opportunity!

Key Management Areas for Preweaned Calves

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

College of Veterinary Medicine

Immune Components

- **Immunoglobulins:**
  - IgG = 85-90% (IgG_1 = 80-90%, IgG_2 = 10-20%)
  - IgA = 5%
  - IgM = 7%
- **Leukocytes** (>10^6 /ml): macrophages, neutrophils, T and B lymphocytes
- **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

(Reiter, 1977; Riedel-Caspari, 1993; Archambault, 1988; Le Jan, 1996; Xu, 1996; Reber et al., 2005)

Nutritional 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

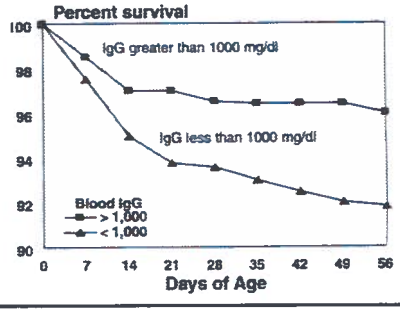
(Davis and Drackley, 1998)

Energy from fat and lactose critical for thermogenesis and maintenance of body temperature (calf born with little reserve energy).

Relationship Between Failure of Passive Transfer and Calf Health

(FPT: Serum IgG < 10 mg/ml)

(USDA:AHPIS:VS, 1992)



Benefits of Achieving Successful Passive Transfer of IgG

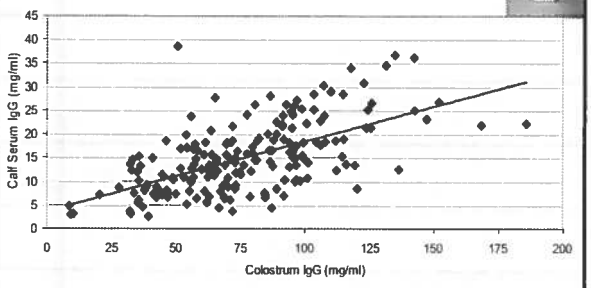
- Reduced treatment and mortality rates
  (NAHMS, Wells, 1996)
- Improved growth rates and feed efficiency
  (Fowler, 1999; Faber et al., 2005; Nocek et al., 1984; Robison et al. 1988; Faber. 2005)
- Decreased age at first calving
  (Faber et al. 2005)
- Increase 1st & 2nd lactation milk production
  (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)



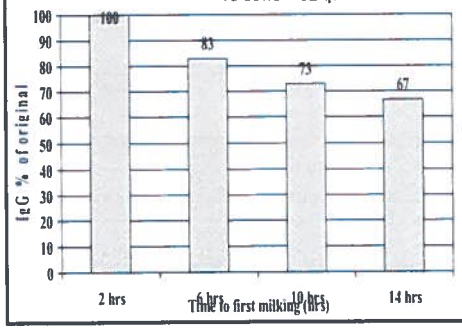
- Positive relationship between IgG in colostrum vs calf serum
- Colostrum quality is highly variable

Factors affecting colostrum quality that ARE under management's control

- Dry Cow Nutrition
- Vaccination During Dry Period
- 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

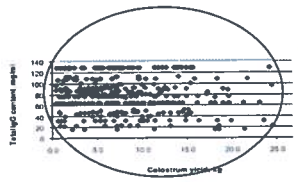
Effect of Delaying First Milking on Colostrum Quality

(Moore et al., J.A.V.M.A. 2005. 226:1375)
13 cows – 52 quarters

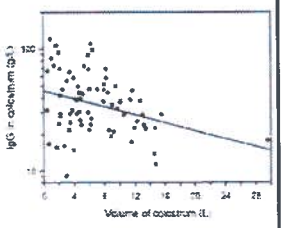


Cause of effect?
-Dilution?
-Reabsorption?

Cow-side tests to predict colostrum quality: Volume produced at first milking?



Grusenmeyer et al., ADSA. 2006



Morin et al., 2010. JAVMA 237:420

Use of weight of the first milking should not be used to identify poor quality colostrum because of low sensitivity (0.42)
(Chigerwe et al. 2008, JAVMA. 223:761)

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% total solids	90.5%	85%	$80	Rapid, Simple, Not temp. dependent

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The 5 Q's of Colostrum Management

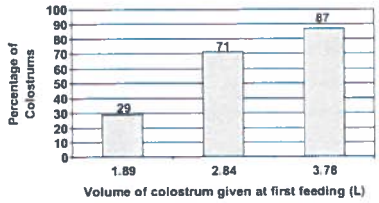
- **Q**uality: > 50 g/L IgG
- **Q**uantity
- **Q**uickness
- S**Q**ueeky clean (bacterial contamination)
- **Q**uantifying passive transfer (monitoring)

2. COLOSTRUM QUANTITY

What volume should we provide at first feeding?

2. QUANTITY FED at FIRST FEEDING

Goal: To achieve Serum IgG ≥ 10 mg/ml, must consume ≥ 100g IgG



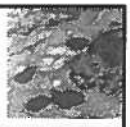
Proportion of colostrum samples expected to provide ≥ 100g of IgG when fed at 3 different volumes (Gay, 1994)

Current Recommendations: Feed 10% of body weight at first feeding = 3.8 L (4 qts) for an average 43 kg (90 lb) Holstein calf

The 5 Q's of Colostrum Management

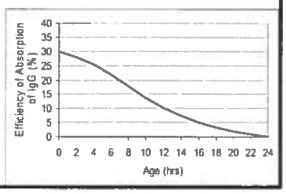
- **Q**uality: > 50 g/L IgG
- **Q**uantity: 10% of Birth Weight
- **Q**uickness:
- S**Q**ueeky clean (bacterial contamination)
- **Q**uantifying passive transfer (monitoring)

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'

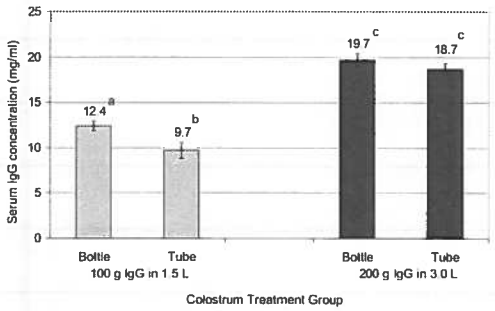
- It's 11:00 PM and the calf was just born
  Goal: Feed within 1-2 hrs (6 hrs max)

- Options:
  - Milk cow and feed calf within 1-2 hrs
  - Feed calf refrigerated stored colostrum
  - Feed calf frozen stored colostrum (don't heat > 60 °C when thawing)
  - Feed a colostrum replacer product

- Bottle vs tube?
  - If tube feed, colostrum deposited in reticulorumen
    - Is delay in emptying important (< 3 hrs)?
  - Volume of reticulorument ≤ 1 L

Bottle vs Tube Feeding / Large vs Small Volumes - Serum IgG Concentrations at 24 hrs

(Godden et al., 2009. JDSci. 92:1758-1764)

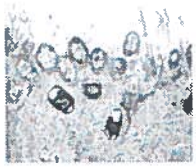


Conclusions: 1. If feeding small volume (1-2 L), is an advantage to using bottle
2. If feeding large volume (3-4 L), no difference between bottle vs tube

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



Colostrum is frequently an early source of microbial exposure

- Goal:
  - Total plate count (TPC) < 100,000 cfu/ml
  - Fecal coliform count < 10,000 cfu/ml
    (McGuirk and Collins. 2004. VCNA Food Animal Practice)
- WI herds: 82% of samples exceeded TPC goal
- MN herds: 93% of samples exceeded TPC goal
  (Poulsen et al.ACVIM. 2002. #52; Swan et al., 2007 . J Dairy Sci. 90:3857-3866)
- Consequences of microbes in colostrum:
  - Pathogens can cause acute or chronic disease
  - Bacteria may interfere with Ig absorption?

3 Major Sources of Colostrum Contamination


1. Infected gland or fecal contamination


2. Contaminated collection, storage or feeding equipment

3. Bacterial proliferation in stored colostrum

Sources of Contamination: 1. Infected Gland or Fecal Contamination

- *Escherichia coli*
- *Salmonella* spp.
- *Mycoplasma* spp.
- *Mycobacterium avium* subsp. *paratuberculosis* (MAP)
- Bovine Leukosis Virus
- *Listeria monocytogenes*
- *Campylobacter jejuni*
- *Staphylococcus aureus*
- *(M. bovis)*
- *(Brucella abortus)*



(Fontaine et al., Am. J. Epidem. 1980. 111:247
Acosta-Martinez et al., AJVR. 1980. 41:1143)

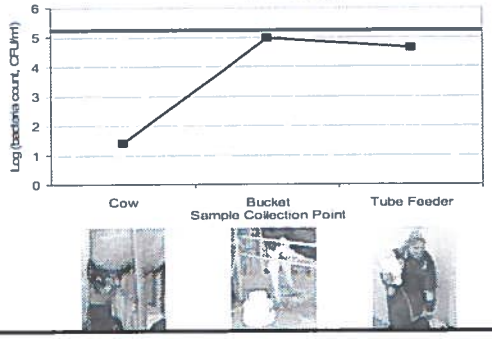
3 Major Sources of Colostrum Contamination

1. Infected gland or fecal contamination
2. Contaminated collection, storage or feeding equipment
3. Bacterial proliferation in stored colostrum

Sources of Contamination:

2. Contamination During Colostrum Harvest

(Stewart et al. JDS. 2005. 88)



3 Major Sources of Colostrum Contamination

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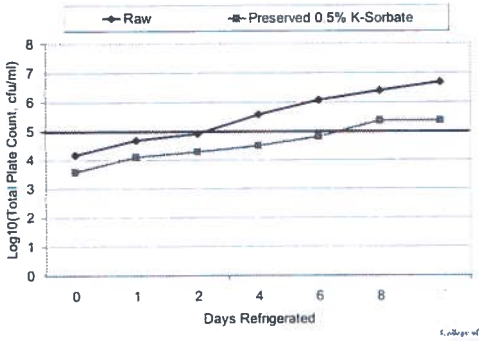
Sources of Contamination:

3. Bacterial Proliferation in Stored Colostrum

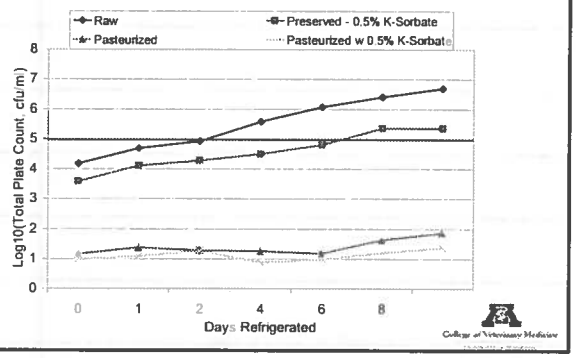
(U of MN, Summer, 2006)



Sources of Contamination:

3. Bacterial Proliferation in Stored Colostrum

(U of MN, Summer, 2006)



Approaches to reduce pathogen exposure through colostrum

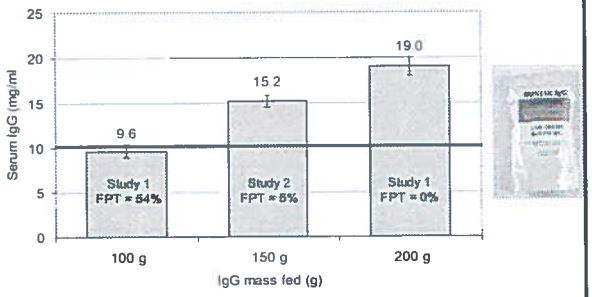
- Avoid pathogens from infected glands, fecal contamination from teat skin:
  - Identify infected cows? (MAP)
  - Don't let calf suckle dam
  - Udder prep
  - Don't pool raw colostrum
- Reduce other sources of contamination:
  - Sanitation of milking, storage & feeding equipment
- Prevent bacterial proliferation in stored clostrum:
  - Feed (< 1-2 hrs), refrigerate (< 48 hrs) or freeze ASAP
  - Use of preservatives?
- Additional tools:
  - Colostrum replacers
  - Heat-treat colostrum

Colostrum Replacement Products

- Must provide:
  - Minimum of 100 gm IgG / dose (plasma- or lacteal-derived Ig)
  - Nutrients (fat, vitamins, minerals, etc.)
  - Cost: $25 to $30 (U.S.D.)
  - Convenient, consistent supply of IgG
- Questions/concerns:
  - Product variability in ability to prevent FPT
  - Promoted as tool to prevent disease transmission?

Dose response of serum IgG to IgG mass fed

(U of MN 2006 LO'L CR Feeding Trials; Godden et al., 2009. 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

Colostrum Replacement Products

- Must provide:
  - Minimum of 100 gm IgG / dose (plasma- or lacteal-derived Ig)
  - Nutrients (fat, vitamins, minerals, etc.)
  - Cost: $25 to $30 (U.S.D.)
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- Questions/concerns:
  - Product variability in ability to prevent FPT
  - Promoted as tool to prevent disease transmission?

Is colostrum a risk factor for transmission of *Mycobacterium avium* subsp. *paratuberculosis* (MAP)?

- 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 CR 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)

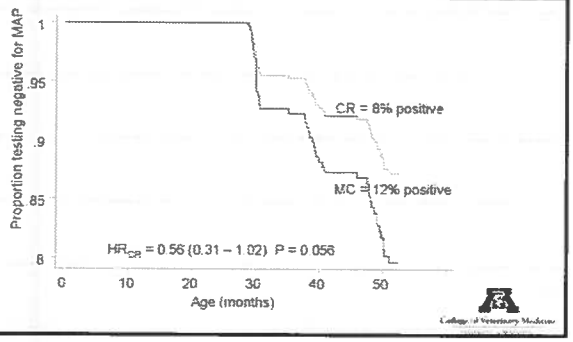
maternal colostrum (n = 261)

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



Approaches to reduce pathogen exposure through colostrum

- Avoid pathogens from infected glands, fecal contamination from teat skin:
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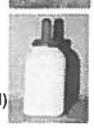
  - Don't pool raw colostrum
- Reduce other sources of contamination:
  - Sanitation of milking, storage & feeding equipment
- Prevent bacterial proliferation in stored clostrum:
  - Feed (< 1-2 hrs), refrigerate (< 48 hrs) or freeze ASAP
  - Use of preservatives?
- Additional tools:
  - Colostrum replacers (feed 150 - 200 g IgG, efficacy tested)
  - Heat-treat colostrum (study ongoing)



Can we reduce bacterial exposure through colostrum? Developing a method to heat-treat colostrum

- Continuous flow (~~72~~ °C x 15 sec) or Batch (~~60~~ °C ~~60~~ min)
  - Unacceptable thickening
  - > 1/3rd loss of IgG (mg/ml)
  - Lower serum IgG in calves

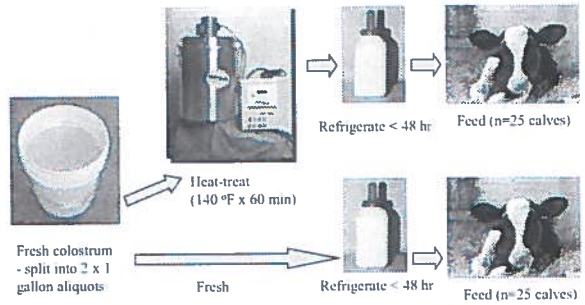
(Green et al. JDSci. 2003. 86:246; Godden et al. JDSci. 2003. 86:1503)

- Batch pasteurize: 60 °C x 60 min
  - No viscosity changes
  - No change in colostrum IgG (mg/ml)
  - Significantly reduce or eliminate *M. paratuberculosis, Salmonella, Mycoplasma bovis, E. coli, Listeria*

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

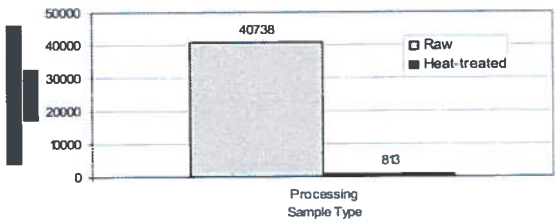
Effect of feeding pasteurized colostrum on colostrum characteristics and passive transfer in calves

(Johnson et al., J.D.Sci. 2007. 90)

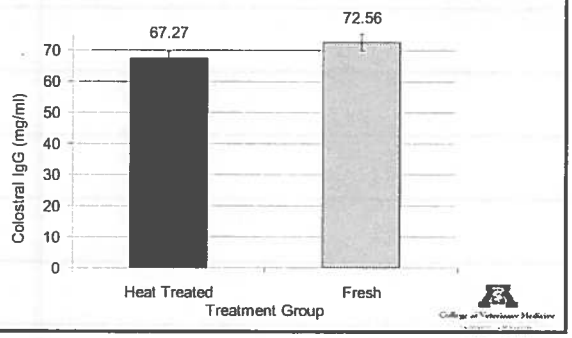


All calves fed 3.8 L colostrum using esophageal tube feeder at < 2 hrs old

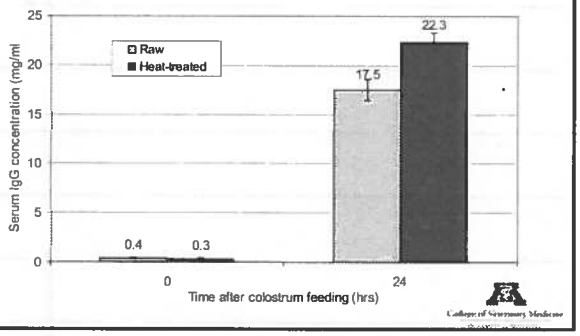
Bacterial counts were significantly reduced in heat-treated colostrum



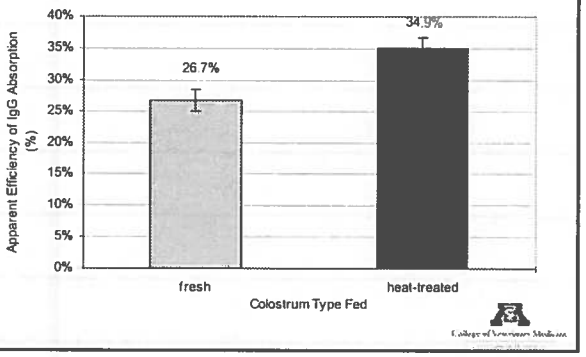
Heat-treatment did not effect colostrum IgG levels



Serum IgG levels were higher in calves fed heat-treated colostrum



Efficiency of IgG absorption was higher in calves fed heat-treated colostrum



- Conclusions (Johnson et al., JDS 2007. 90)
  - Feeding pasteurized colostrum resulted in:
    - No effect on IgG levels in colostrum
    - Reduced bacterial exposure through colostrum
    - Improved passive transfer of IgG in calves
- Will feeding pasteurized colostrum control the transmission of Johne's disease?
  - Summer 2007: initiate large field study
  - 1100 calves enrolled from 6 herds
  - Calves fed pasteurized colostrum had:
    - Improved IgG levels
    - No effect on preweaning health, growth
  - Adulthood – study in progress:
    - Risk for MAP infection, longevity, production



Summary of approaches to reduce pathogen exposure through colostrum

- Avoid pathogens from infected glands, fecal contamination from teat skin:
  - Identify infected cows? (MAP)
  - Don't let calf suckle dam
  - Udder prep
  - Don't pool raw colostrum
- Reduce other sources of contamination:
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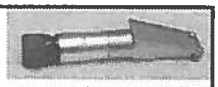
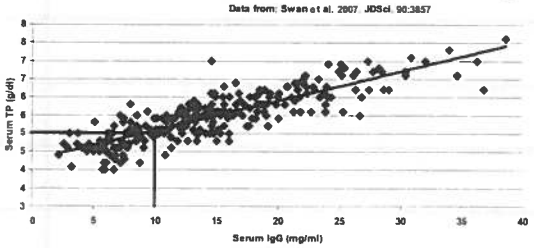
- **Q**uantity: 10% of Birth Weight
- **Q**uickness: ASAP (1-6 hrs)
- S**Q**ueeky clean: TPC < 100,000 cfu/ml
- **Q**uantifying passive transfer (monitoring)

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



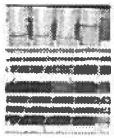
refractometer



- TP value to predict serum IgG of 10 mg/ml:
  - 5.0 or 5.2 g/dl: fed maternal colostrum or colostrum based replacer
  - 4.75 g/dl: If fed plasma-based replacer (Calloway, et al., 2002; Place et al., 2010)

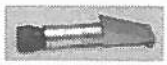
On-farm monitoring of serum total protein to evaluate the colostrum program

- How?
  - Bleed 12 clinically normal calves 24 hrs – 7 d old
  - Let blood clot, test serum with refractometer
  - Interpret results at the group level



- Goal:
  ≥ 90% of calves should have TP ≥ 5.0 g/dl
  Tyler. 2003. p.c.

  or ≥ 80% of calves should have TP ≥ 5.5 g/dl
  McGuirk, 2006



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- **Q**uantifying passive transfer: monitor STP

Summary

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

- 5 Q's of colostrum management:
  - Quality: > 50 g/L IgG
  - Quantity: 10% of Birth Weight
  - Quickness: ASAP (1-6 hrs)
  - SQueeky clean: TPC < 100,000 cfu/ml
  - Quantifying passive transfer: monitor STP

College of Veterinary Medicine

Thank you!

Colostrum Management for Dairy Calves

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Introduction

The syndesmochorial placenta of the cow separates the maternal and fetal blood supplies, preventing in-utero transmission of protective immunoglobulins (Ig) [1]. Consequently, the calf is born aggamagobulinemic and so is almost entirely dependent upon the absorption of maternal Ig from colostrum after birth. The absorption of maternal Ig across the small intestine during the first 24 hours after birth, termed passive transfer, helps to protect the calf against common disease organisms until its own immature immune system becomes functional. Calves are defined as having failure of passive transfer (FPT) if the calf serum IgG concentration is less than 10 mg/ml when sampled between 24 – 48 hours of age [2, 3]. Achieving early and adequate intake of high quality colostrum is widely recognized as the single most important management factor in determining health and survival of the neonatal calf (Figure 1) [3, 4, 5, 6]. In addition to reduced risk for preweaning morbidity and mortality, additional long term benefits associated with successful passive transfer include reduced mortality in the postweaning period, improved rate of gain and feed efficiency, reduced age at first calving, improved first and second lactation milk production, and reduced tendency for culling during the first lactation [7, 8, 9, 10].

Unfortunately, many producers continue to incur significant loss associated with FPT. In the United States mortality rates in preweaned dairy heifers are estimated to range between 8 – 11% [2, 4, 11]. Poor colostrum management is one of the key factors contributing to these excessive losses. In one study 41% of 2177 calves sampled between 24 to 48 hours of age had FPT (serum IgG < 10 mg/ml) [2]. It was estimated that approximately 31% of preweaning mortality events occurring in the first three weeks of life were attributed to FPT [9]. These studies point to the need for producers to adopt practices to improve colostrum management. This chapter will review the process of colostrogenesis and discuss important components of colostrum. It will then discuss the key components of developing a successful colostrum management program.

Colostrogenesis and Colostrum Composition

Bovine colostrum consists of a mixture of lacteal secretions and constituents of blood serum, most notably Ig and other serum proteins, which accumulate in the mammary gland during the prepartum dry period [12]. This process begins several weeks prior to calving, under the influence of lactogenic hormones including prolactin, and ceases abruptly at parturition. Important constituents of colostrum include Ig, maternal leukocytes, growth factors, hormones, cytokines, non-specific antimicrobial factors and nutrients. Concentrations of many of these components will be greatest in the first secretions harvested after calving (first milking colostrum), then decline steadily over the next 6 milkings (transition milk) to reach the lower concentrations routinely measured in saleable whole milk (Table 1) [12].

Immunoglobulins. IgG, IgA and IgM account for approximately 85-90%, 5% and 7%, respectively, of the total Ig in colostrum, with IgG_1 accounting for 80-90% of the total IgG [13]. Though levels are highly variable among cows and studies, one study reported that mean colostral concentrations of IgG, IgA and IgM were 75 mg/ml, 4.4 mg/ml, and 4.9 mg/ml, respectively [14]. IgG, and IgG_1 in particular, are transferred from the blood stream across the mammary barrier into colostrum by a specific transport mechanism: Receptors on the mammary alveolar epithelial cells capture IgG_1 from the extracellular fluid, the molecule undergoes endocytosis, transport, and finally release into the luminal secretions [13]. The alveolar epithelial cells cease expressing this receptor, most likely in response to rising prolactin concentrations, at the onset of lactation [15]. Smaller amounts of IgA and IgM are largely derived from local synthesis by plasmacytes in the mammary gland [13]. Though not well understood, colostral transfer of IgE also occurs and may be important in providing early protection against intestinal parasites [16].

Maternal Leukocytes. Normal bovine colostrum contains greater than 1×10^6 cells per milliliter of immunologically active maternal leukocytes including macrophages, T and B lymphocytes, and neutrophils [13, 17]. At least a portion of colostral leukocytes are absorbed intact across the intestinal barrier [18]. Liebler-Tenorio et al. [19] reported that the preferential route of uptake of colostral leukocytes through the intestinal barrier is through the follicle-associated epithelium of Peyer's patches in the jejunum and ileum. Reber et al. [20] proposed that, after entering the neonatal circulation, maternal leukocytes traffic to both neonatal non-lymphoid tissues and secondary lymphoid tissues, disappearing from the neonatal circulation by 24-36 hours after feeding colostrum. Although their functional importance in calves is not routinely measured, early evidence suggests that colostral leukocytes enhance lymphocyte response to nonspecific mitogens, increase phagocytosis and bacterial killing ability, and stimulate humoral immune responses (IgG formation) in the calf [17, 21, 22, 23]. Presumably these cells would not be viable in pasteurized colostrum or colostrum replacer products. The role and functional significance of colostral leukocytes remains an area of active research.

Cytokines and Growth Factors. Other important components of colostrum include growth factors, hormones, cytokines, and non-specific antimicrobial factors. Bioactive components of colostrum with antimicrobial activity include include lactoferrin, lysozyme and lactoperoxidase [24, 25, 26]. Oligosaccharides in colostrum may provide protection against pathogens by acting as competitive inhibitors for the binding sites on the epithelial surfaces of the intestine [27]. Growth factors in bovine colostrum include transforming growth factor beta-2 (TGF-β2), growth hormone (GH), and insulin, but their function in colostrum is not fully understood (Table 1) [24]. Colostral insulin-like growth factor-I (IGF-I) may be a key regulator in the development of gastrointestinal tracts of bovine neonates, including stimulation of mucosal growth, brush-border enzymes, intestinal DNA synthesis, increased villus size, and glucose increased uptake [28, 29, 30]. Trypsin inhibitor, a compound found in colostrum in concentrations nearly 100 times greater than in milk, serves to protect IgG and other proteins from proteolytic degradation in the intestine of the neonatal calf.

Nutrients. While the immunologic importance of colostrum is frequently discussed, the nutritional significance of the first colostrum meal should not be overlooked. The total solids content (%) in first milking colostrum and whole milk in Holstein cows has been reported to average 23.9% and 12.9%, respectively (Table 1) [12]. Much of this increase in colostrum solids content is attributed to a more than fourfold increase in protein content of colostrum vs milk, this being due to significant increases in both Ig and casein content [5]. The crude fat content of first milking Holstein colostrum (6.7%) is also significantly higher than for milk (3.6%) [12]. Energy from fat and lactose in colostrum is critical for thermogenesis and body temperature regulation. Certain vitamins and minerals, including Calcium, Magnesium, Zinc, Manganese, Iron, Cobalt,

Vitamin A, Vitamin E, Carotene, Riboflavin, Vitamin B12, Folic acid, Choline, and Selenium are also found in increased concentrations in bovine colostrum vs milk (Table 1) [12, 27].

Components of a Successful Colostrum Management Program

To achieve successful passive transfer of IgG, the calf must first consume a sufficient mass of Ig in colostrum, and then be able to successfully absorb a sufficient quantity of these molecules into its circulation. Major factors affecting the mass of Ig consumed by the calf include the quality and volume of colostrum fed. The major factor affecting the absorption of Ig molecules into circulation is the quickness, after birth, with which the first colostrum feeding is provided. The remainder of this chapter will review these and other important factors affecting passive transfer, management strategies for preventing bacterial contamination of colostrum, the use of colostrum supplements and replacers, and provide recommendations for monitoring the colostrum management program.

1. Colostrum Quality

Though it is recognized that colostrum contains a wide spectrum of important immune and nutritional components, because the relationship between Ig concentrations and calf health is best understood, and because IgG comprises more than 85% of total Ig in colostrum, the concentration of IgG in colostrum has traditionally been considered the hallmark for evaluating colostrum quality. High quality colostrum has an IgG concentration > 50 g/L [6]. However, the IgG concentration in colostrum can vary dramatically among cows. In one recent study, colostrum IgG averaged 76 g/L, but ranged from 9 to 186 g/L for individual Holstein cows [31]. Some factors affecting colostrum quality, such as breed or age of the dam, may be out of the producer's ability to manipulate. However, several other important factors affecting colostrum quality, including preparturient vaccination, dry period length, and time to colostrum collection, can be managed by producers. This section will review factors affecting colostrum quality and discuss cow-side testing of colostrum quality.

Breed. Comparative studies have reported that there can be a breed effect on colostrum quality [32, 33]. In one study, IgG_1 concentration was greater in secretions from beef cows (113.4 g/L) than from dairy cows (42.7 g/L) [32]. In another study, Holstein cows produced colostrum with total Ig content (5.6%) that was numerically lower than for Guernsey (6.3%) and Brown Swiss (6.6%) cows, and statistically lower than for Ayrshire (8.1%) and Jersey (9.0%) cows [33]. Breed differences could be attributed to genetic differences and/or dilutional effects.

Age of Dam. Most, but not all, studies report a tendency for older cows to produce higher quality colostrum, presumably due to older animals having had a greater period of exposure to farm-specific pathogens [33, 34, 35, 36]. As one example, Tyler et al. [36] reported that the mean colostral IgG concentration for Holstein cows in their first, second, or third and greater lactations was 66, 75, and 97 g/L, respectively. However, in the same study there was reportedly no difference in IgG concentration for Guernsey cows in their first (119 g/L), second (113 g/L) and third and greater lactations (115 g/L). Producers should be discouraged from automatically discarding colostrum from first calf heifers, as it may be of very good quality.

Nutrition in the Preparturient Period. Studies have generally have shown that Ig content of colostrum is not affected by prepartum maternal nutrition [37]. In a study feeding beef cows either 100% (CO) or 57% (RS) of NRC (1984) [38] protein and energy requirements, maternal nutrition did not affect either colostrum IgG concentration (43.0 vs 39.5 g/L for RS and CO, respectively) or the calves' serum IgG concentration at 24 hours (19.1 vs 20.2 mg/ml for RS and

CO, respectively) [39]. Lacetera et al. [40] reported that cows supplemented with injections of selenium and vitamin E in late pregnancy produced a greater volume of colostrum than unsupplemented cows, when all cows were fed a prepartum diet that was deficient in Vitamin E and selenium. However treatment had no impact on colostrum IgG concentration. Producers should feed dry cows and heifers non-lactating rations balanced according to NRC (2001) guidelines [41].

Season of Calving. Some, but not all, studies have reported that exposure to high ambient temperatures during late pregnancy is associated with poorer colostrum composition, including lower mean concentrations of colostral IgG and IgA, and lower mean percentages of total protein, casein, lactalbumin, fat, and lactose [34, 42]. These effects may be attributed to the negative effects of heat stress on dry matter intake resulting in nutritional restriction, reduced mammary blood flow resulting in impaired transfer of IgG and nutrients from the blood stream to the udder, and/or impaired immune reactivity of mammary gland plasmacytes that produce IgA [42]. Producers should adopt the similar heat-abatement strategies for prepartum cows and heifers as are routinely utilized for lactating animals.

Volume of Colostrum Produced. Pritchette et al. [35] observed that cows producing < 8.5 kg of colostrum at first milking were more likely to produce high quality (> 50 g/L) colostrum than cows producing higher quantities of first milking colostrum (≥ 8.5 kg). This was presumed to be due to dilutional effects. However, more recent studies report that there is no predictable relationship between colostrum IgG concentration and weight of colostrum produced at first milking [43, 44].

Mastitis. Persistent intramammary infection (IMI) during the nonlactating period has not been associated with altered IgG1 concentration. However, IMI is associated with lower colostral volume produced [45]. Producers should not feed colostrum from cows with clinical mastitis.

Pooling. Pooling of colostrum from multiple dams is generally discouraged for the reason that larger volumes of low quality colostrum may dilute smaller volumes of higher quality colostrum [3]. Furthermore, pooling raw colostrum may increase the number of calves potentially exposed to colostrum-borne pathogens.

Preparturient Vaccination of the Dam. While not all studies have shown positive results, a large body of research has established that vaccinating the pregnant cow or heifer during the final 3 to 6 week period preceding calving results in increased concentrations of protective colostral antibodies, and increased passive antibody titers in calves of vaccinated dams, for some common pathogens including *Pasteurella haemolytica*, *Salmonella typhimurium*, *Escherichia coli,* rotavirus and coronavirus [46, 47, 48, 49, 50].

Dry Period Length. Secretion of Ig from the dam's circulation into the mammary gland begins approximately 5 weeks prior to calving. In one observational study, dry period length (mean = 57.5 ± 11 days) was not associated with colostrum IgG concentration [35]. In a controlled study, Rastani et al., [51] also reported that colostrum quality was not different for cows with a 28 or 56 day dry period, respectively. However, cows with excessively short dry periods (< 21 days) or no dry period produce colostrum with significantly lower IgG concentrations [51, 52]. Furthermore, dry period length can affect the volume of colostrum produced: In a recent controlled field study cows with a short (40 day) dry period produced 2.2 kg less colostrum than did cows with a conventional (60 day) dry period [44].

Delayed Colostrum Collection. The concentration of Ig in colostrum is highest immediately after calving, but begins to decrease over time if milking is delayed. In one study, delaying harvest of colostrum for 6 hrs, 10 hrs, or 14 hrs after calving resulted in a 17%, 27% and 33% decrease in colostral IgG concentration, respectively [53]. To collect the highest quality colostrum, producers should aim to milk the cow within 1-2 hrs after calving if possible, with a maximum delay of 6 hours.

Cow-side Testing of Colostrum Quality. Empirical recommendations suggest rejecting colostrum that is visibly watery, bloody, or is from cows that leaked prior to calving [54]. However, it is difficult to predict, based on such factors as dam parity, weight of colostrum produced at first milking, or visual consistency, which colostrum collected will be of high (> 50 g/L IgG) vs low quality [43]. The colostrometer, a hydrometer instrument that estimates IgG concentration by measuring colostrum specific gravity, is one rapid and inexpensive cow-side test that may be useful to differentiate high from low quality colostrum (specific gravity > 1.050 approximates IgG concentration > 50 g/L IgG). However, factors such as content of fat and other solids, plus colostrum temperature, will affect the hydrometer reading. Pritchett et al. [55] reported that the sensitivity and specificity of the instrument for detecting low quality colostrum was 0.32 and 0.97, respectively, meaning that the instrument would incorrectly classify two of every three low-quality colostrum samples as acceptable. Pritchett et al. [55] suggested that to avoid misclassification error, producers should alter the hydrometer cutoff points to 45, 60 or 110 g/L if feeding either 3.78, 2.84, or 1.89 L of colostrum at first feeding, respectively. However, test specificity would be severely compromised by using higher cutpoints, resulting in an excessive portion of colostrums being misclassified as deficient [3]. Others have suggested that if a large enough volume (e.g. 3.78 L) is fed at first feeding, then there may be limited value to using a hydrometer. Despite its limitations, the hydrometer may still be useful to differentiate high from low quality colostrums used for first versus later feedings, respectively.

The Brix refractometer, which measures total solids content, is another cow-side tool recently evaluated for evaluating colostrum quality. Bielmann et al., (2010) reported that both optical and digital Brix refractometer instruments have acceptable test sensitivities (90.5%) and specificities (85%) when compared with the gold standard RID laboratory test, indicating that they are capable of differentiating between good (≥ 50 g/L) and poor quality colostrum. The authors suggested that the appropriate cut-off level is a Brix score equal to or above 22% to ensure colostrum is of good quality [103].

An alternate tool for differentiating high from low quality colostrum may be a commercially available cow-side immunoassay kit (Colostrum Bovine IgG Quick Test Kit. Midland Bio-Products, Boone, IA). Chigerwe et al. [56] recently reported that the sensitivity and specificity of this test kit to identify poor quality colostrum (IgG < 50 g/L) was 0.93 and 0.76, respectively. With this relatively low specificity, the immunoassay test would incorrectly classify one in every four high quality colostrum samples as unacceptable. One additional limitation of the immunoassay is that it yields only a positive or negative result, but does not provide an estimate of the actual IgG concentration. The immunoassay costs approximately $4 (USD) per sample and takes approximately 20 minutes to run.

2. Volume of Colostrum Consumed at First Feeding.

In order to achieve successful passive transfer in an average 43 kg (90 lb) Holstein calf, experts calculate that producers should feed at least a minimum mass of 100 g of IgG in the first colostrum feeding [5]. So what volume of colostrum should producers feed in order to meet or exceed this minimum dose? Obviously the answer to this question depends on the IgG

concentration in the colostrum being fed. For example, if colostrum was known to contain 50 g/L IgG, then the producer would only need to feed 1.89 L (2 qt) to achieve the goal of ingesting > 100 g IgG. However, if the colostrum only contained 25 g/L of IgG, then the producer would need to feed 3.78 L (4 qt) to achieve the same ingested mass of IgG. Besser et al., [57] noted that only 36% of colostrum samples tested would be of high enough quality to provide > 100 g IgG if calves were only fed 1.89 L. However, 85% of colostrum samples tested would be of high enough quality to provide > 100 g IgG if calves were fed 3.78 L. Because producers frequently do not know the concentration of IgG in the colostrum being fed, it is currently recommended that calves be fed 10-12% of their body weight of colostrum at first feeding (= 3.78 L for a 43 kg calf). In one study mean serum IgG at 24 hrs was significantly higher for calves fed 4 L of high quality colostrum at 0 hrs and a further 2 L at 12 hrs (31.1 mg/ml IgG) as compared to calves fed only 2 L of high quality colostrum at 0 hrs and a further 2 L at 12 hrs (23.5 mg/ml) (Figure 20 [58]. Another study reported that Brown Swiss calves fed 3.78 L (vs 1.89 L) of colostrum at first feeding experienced significantly higher rates of average daily gain and greater levels of milk production in both the first and second lactation [10]. In national surveys, 26.1%, 35.9%, and 38.2% of producers reported feeding 4 or more quarts of colostrum within the first 24 hrs in 1992, 1996, and 2002, respectively [2, 4, 11], indicating that increasing volume of colostrum fed is still an area of opportunity for the majority of dairy producers.

3. Efficiency of Absorption of Immunoglobulins

The term 'open gut' refers to the unique ability of the neonatal enterocyte to nonselectively absorb intact large molecules, such as Ig, by pinocytosis [59]. From there, Ig molecules are transported across the cell and released into the lymphatics by exocytosis, after which they enter the circulatory system through the thoracic duct [60]. In a process referred to as 'closure', the efficiency of colostral Ig absorption through the intestinal epithelium of the calf decreases linearly with time from birth to completely close at approximately 24 hrs [3]. Feeding colostrum after the gut has closed will still offer the benefit of local immunity in the gut lumen, but Ig absorption into the circulation will no longer occur. The following section will discuss factors affecting the efficiency of Ig absorption, many of which are under management's control.

Time to First Colostrum Feeding. The major factor affecting efficiency of Ig absorption is age of the calf at feeding. The efficiency of Ig transfer across the gut epithelium is optimal in the first 4 hours postpartum, but after 6 hours there is a progressive decline in the efficiency of Ig absorption over time [61, 62]. Delaying the first colostrum feeding can only slightly postpone gut closure (36 hrs) [63]. Producers should aim to feed all calves within 1-2 hours after birth, and by 6 hours at a maximum.

Method of Feeding. The method of feeding colostrum is worth considering because this can influence the time to first feeding, the volume consumed, and the efficiency of Ig absorption. High rates of FPT have been reported in calves left to suckle the dam [57, 64]. This may be due to failure of the calf to voluntarily consume a sufficient volume of colostrum, as well as delays in suckling. Edwards and Broom [65] reported that 46% of calves born to 2nd parity and older cows had failed to suckle within 6 hours after birth. By comparison, 11% of calves born to first calf heifers had failed to suckle within 6 hours after birth. These delays could be due to numerous factors including weak or injured cow or calf, mastitis or other illness in the cow, low pendulous udders or large teats, or poor mothering ability. It is for this reason that it is currently recommended that the calf be removed from the dam within 1-2 hours of birth, and that the calf then be hand fed a known volume of colostrum using either a nipple bottle or oesophageal feeder [6]. In national surveys, 68.1%, 70.5%, and 76.2% of calves were reportedly fed using a nipple

bottle or oesophageal tube in 1992, 1996, and 2002, respectively [2, 4, 11], indicating that progressively fewer producers are relying on suckling the dam for colostrum delivery.

Producers may have a personal preference for using either a nipple bottle or oesophageal feeder for the first colostrum feeding. Though the oesophageal feeder method is quicker, it is known that when fluid is given with an oesophageal feeder, the oesophageal groove reflex is not triggered, resulting in fluid being deposited into the forestomachs. However, this is not a significant limitation because outflow of colostrum from the forestomachs to the abomasum and small intestine occurs for the most part within 3 hours [66]. Adams et al. [67] reported that calves fed colostrum using a bottle had only slightly higher serum IgG concentrations vs calves fed with an oesophageal feeder, but that these differences were numerically small and statistically insignificant. It is generally accepted that either method of feeding will achieve acceptable rates of passive transfer provided a sufficient volume of colostrum is consumed [67, 68]. Veterinarians should train interested producers on how to properly use and clean oesophageal feeders.

Presence of the Dam. It has been reported that efficiency of Ig absorption was improved when calves were housed with the dam [69]. However, considering that very acceptable levels of serum IgG can be achieved without housing the calf with the dam, and given that the latter practice may increase the calf's risk of exposure to pathogens from the dam or her environment, it is currently recommended that the calf be removed from the dam within 1-2 hours of birth and then hand fed a known volume of colostrum [6].

Metabolic Disturbances. Decreased colostral Ig absorption in the first 12 hrs has been reported in calves with postnatal respiratory acidosis, associated with prolonged parturition [70]. However, while hypoxic calves may have delayed IgG absorption initially, studies have reported that there is no difference in overall absorptive capacity between hypoxic and normoxic calves, and that there is no difference in serum IgG concentrations by the time of gut closure [71, 72]. Weaver et al., [3] suggested that an increased rate of FPT seen in calves with metabolic or respiratory acidosis may be caused by a delay in the animal getting up to nurse, not by reduced absorptive capacity.

Cold Stress. Absorption of Ig may be impaired when newborn calves are exposed to extreme cold. This could be due to direct effects on intestinal absorption and transport as well as indirect effects on the calf's ability to stand and nurse [73].

Bacterial Contamination of Colostrum. Bacteria in colostrum may bind free Ig in the gut lumen and/or directly block uptake and transport of Ig molecules across intestinal epithelial cells, thus interfering with passive absorption of colostral Ig [74, 75, 76]. This effect was demonstrated in a recent controlled study wherein newborn calves were fed either 3.8 L of pasteurized (60 °C x 60 min) colostrum or 3.8 L of raw colostrum, with the geometric mean total bacteria counts in the two colostrum treatment groups being 813 cfu/ml or 40,738 cfu/ml, respectively [77]. Though the volume, timing and quality of colostrum fed to the two feeding groups was not different, calves fed pasteurized colostrum had significantly higher mean serum IgG levels at 24 hrs of age (22.3 mg/ml) vs. calves fed raw colostrum (18.1 mg/ml). The authors hypothesized that this improvement may be due to reduced bacterial interference with IgG absorption across the gut, resulting in higher efficiency of IgG absorption in calves fed pasteurized colostrum (35%) vs calves fed raw colostrum (27%) [77]. Strategies for preventing or minimizing bacterial contamination of colostrum are discussed in the next section.

4. Strategies for Preventing Bacterial Contamination of Colostrum

Though colostrum is an important source of nutrients and immune factors, it can also represent one of the earliest potential exposures of dairy calves to infectious agents including *Mycoplasma* spp., *Mycobacterium avium* subsp. *paratuberculosis* (*Map*), fecal coliforms and *Salmonella* spp. [78. 79, 80]. This is a concern because pathogenic bacteria in colostrum could cause diseases such as diarrhea or septicemia. As was previously discussed, this is also a concern because bacteria in colostrum may interfere with absorption of Ig [74, 75, 76]. Experts recommend that fresh colostrum fed to calves contain fewer than 100,000 cfu/ml total bacteria count (TPC) and fewer than 10,000 cfu/ml total coliform count [6]. Unfortunately, average bacteria counts in colostrum fed on commercial dairies frequently far exceeds this cutpoint [31, 76]. In one study of Wisconsin dairy herds, 82% of samples tested exceeded the upper limit of 100,000 cfu/ml TPC [76]. The following section describes management techniques for minimizing bacterial contamination of colostrum.

Preventing Contamination During Colostrum Harvest, Storage and Feeding Procedures. Methods for reducing the risk of pathogen exposure to calves include avoiding feeding colostrum from known infected cows and avoiding pooling of raw colostrum. Additionally, all producers should take steps to avoid contamination during colostrum harvest, storage or feeding processes: In a study of colostrum harvesting and feeding practices on one dairy, total bacteria counts (TPC cfu/ml) were very low or nil in colostrum stripped directly from the gland (geometric $mean_{udder}$ TPC = 27.5 cfu/ml). However, significant bacterial contamination occurred during the process of milking the colostrum into the bucket (geometric $mean_{bucket}$ TPC = 97,724 cfu/ml) [81]. These results emphasize the importance of minimizing colostrum contamination by properly prepping udders prior to harvesting colostrum, milking into a clean, sanitized bucket, and handling colostrum using clean, sanitized storage or feeding equipment.

Minimizing Bacterial Growth in Stored Colostrum. Bacteria can multiply rapidly if colostrum or milk is stored at warm ambient temperatures [81]. Unless colostrum is to be fed right away, it should be frozen or refrigerated within 1 hour after collection. It is generally accepted that colostrum may be frozen for up to 1 year, provided repeated multiple freeze-thaw cycles do not occur. When thawing frozen colostrum, producers should avoid overheating colostrum (avoid temperatures > 60 °C or 140 °F) or some denaturation of colostral Ig can occur [82]. Options for producers who wish to store fresh colostrum include refrigeration, with or without the use of preservatives such as potassium sorbate [81]. IgG in raw refrigerated colostrum is stable for at least one week However, average bacteria counts in raw refrigerated colostrum may reach unacceptably high concentrations (> 100,000 cfu/ml) after 2 days of refrigeration. By comparison, average colostrum bacteria counts remained < 100,000 cfu/ml for 6 days of refrigeration when colostrum preserved with potassium sorbate in a 0.5% final solution [81]. Information on potassium sorbate sources and mixing directions can be found at: http://www.atticacows.com/orgMain.asp?orgid=19&storyTypeID=&sid=&.

Pasteurizing Colostrum. An additional tool which may be useful to reduce bacterial contamination of colostrum is pasteurization. Early studies tried to pasteurize colostrum using the same conventional methods and high temperatures as are typically used to pasteurize milk (63 °C (145 °F) for 30 min or 72 °C (161 °F) for 15 sec). However, this yielded unacceptable results, including thickening or congealing of colostrum and denaturation of approximately $1/3^{rd}$ of colostral IgG [83]. Despite these early setbacks, more recent research has determined that using a lower-temperature, longer-time approach (60 °C (140 °F) for 60 minutes) to batch pasteurize colostrum is sufficient to maintain IgG activity and colostrum fluid characteristics, while eliminating or significantly reducing important pathogens including *E. coli*, *Salmonella*

enteritidis, *Mycoplasma bovis* and *Mycobacterium avium* subsp. *paratuberculosis* [82, 84]. In one recent on-farm controlled study, calves fed pasteurized colostrum (60 °C x 60 min) experienced a significant reduction in colostrum bacterial exposure and significantly higher serum IgG levels at 24 hrs of age vs calves fed 3.8 L of raw colostrum [77]. If stored in a clean covered container, the shelf life of pasteurized refrigerated colostrum is at least 8 to 10 days [85]. The potential short- and long-term health and economic benefits of feeding pasteurized colostrum have not yet been described.

5. Use of Colostrum Supplements or Replacement Products

Farms can occasionally experience periods when an adequate supply of clean, high quality fresh or stored colostrum is not available to feed to all newborn calves. Contributing to this problem, some producers may discard colostrum from cows that test positive for *Mycobacterium avium* subspecies *paratuberculosis*, Bovine Leukosis virus, or *Mycoplasma bovis* mastitis. Under such circumstances, using colostrum supplements (CS) or colostrum replacement (CR) products may offer producers a convenient way to improve levels of passive immunity in calves while reducing the risk of pathogen exposure through colostrum. Powdered commercial CS or CR products contain bovine Ig that is typically either lacteal- or plasma-derived. It is recommended that CS or CR products be mixed in water (according to label directions) and fed as a separate meal after any natural colostrum has been fed [6]. There are important differences between the less expensive CS products ($5-7/dose) and more expensive CR products ($25-$30/dose). Colostrum supplement products typically contain < 50 g IgG per dose, contain no nutrient pack, and are only intended to supplement (not replace) existing colostrum. If given alone, feeding CS products results in significantly lower serum Ig and greater risk of FPT in calves as compared to feeding fresh colostrum [86]. There is no added benefit of feeding CS products if already feeding 3-4 L of high quality bovine colostrum [87, 88]. By comparison, CR products contain a minimum of 100 g IgG per dose, provide a nutritional source of protein, energy, vitamins and minerals, and are designed to completely replace (or feed in the absence of) maternal colostrum [89].

Results of CR studies have been mixed, with many products failing to routinely provide the necessary 10 mg/ml IgG in serum of calves fed CR [31, 89, 90, 91]. In a controlled study of 12 dairy herds in Minnesota and Wisconsin, Swan et al.,[31] reported that 239 commercial dairy calves fed a commercially available CR product (Acquire. American Protein Corporation, Inc., Ames, IA) had significantly lower serum IgG concentrations (5.8 mg/ml IgG) than 218 calves fed maternal colostrum (14.8 mg/ml IgG). Though a trend was present, the preweaning morbidity and mortality rates were not different for calves fed CR (morbidity = 59.6%; mortality = 12.4%) vs calves fed maternal colostrum (morbidity = 51.9%; mortality = 10%). Other studies have reported better rates of successful passive transfer (mean serum IgG > 10.0 mg/ml), particularly when calves were fed 2 doses of CR product [89, 92]. In one such study, the average 24 hr serum IgG level for calves fed either 1 dose (100 g IgG) or 2 doses (200 g IgG) of a lacteal-derived CR, or 3.78 L of maternal colostrum were 11.6, 16.9, and 27.2 mg/ml IgG, respectively (Land O' Lakes Colostrum Replacement. Land O' Lakes Inc. St. Paul, MN) [93]. Feeding higher doses of CR products may increase the rate of successful passive transfer, but the cost-benefit of this practice has yet to be described. In one recent study conducted on 12 commercial dairy herds in Minnesota and Wisconsin, calves originally fed a CR at birth were less likely (hazard ratio = 0.56) to become infected with *Mycobacterium avium* subspecies *paratuberculosis* (as determined by use of a serum ELISA and fecal culture tests in the first 54 months of life) compared with the likelihood of infection for calves originally fed raw maternal colostrum at birth [102]. Despite these promising results, the effectiveness and cost-benefit of routinely using CR products in Johne's and other infectious disease control programs requireds further study. Because of the

highly variable performance among different products, veterinarians should review results of peer-reviewed controlled trials when selecting a CR product.

6. Monitoring the Colostrum Management Program

Veterinarians can help producers develop programs to routinely monitor colostrum management. Possible laboratory-based test methods for directly measuring or estimating serum IgG concentrations in calves include radial immunodiffusion (RID), turbidimetric immunoassay (TIA), enzyme-linked immunosorbent assay (ELISA), sodium sulfite turbidity test, zinc sulphate turbidity test, serum GGT activity, and whole-blood glutaraldehyde coagulation test [94, 95, 96]. In a recent review of these tests, Weaver et al., [3] raised concerns about unacceptably high levels of inaccurate results for the sodium sulfite turbidity test when using the 14% and 16% sodium sulfite test solutions, the zinc sulfate turbidity test if samples are exposed to CO_2 or are hemolyzed, GGT test results, and whole-blood glutaraldehyde coagulation test results. While RID, TIA or ELISA would be acceptable tests for use in periodic outbreak investigations, the expense and inconvenience of routinely submitting serum samples to a veterinary diagnostic laboratory would generally discourage their adoption for ongoing monitoring programs.

A lateral-flow immunoassay is one tool that could be used for on-farm testing (Midland Quick Test Kit – Calf IgG. Midland BioProducts Corp. Boone, IA). The manufacturer has reported the sensitivity, specificity, and overall accuracy of this assay to identify calves with serum IgG < 10.0 mg/ml as being 0.99, 0.89, and 0.94, respectively [97]. Independent validation of this test is still required. One limitation of the immunoassay is that it yields only a positive or negative result, but does not provide an estimate of the actual serum IgG concentration. The assay requires approximately 20 minutes to complete and costs approximately $4.50 (USD) per sample.

Measurement of serum total protein (STP) by hand-held refractometer offers a convenient, simple, rapid and inexpensive on-farm tool by which producers can monitor the colostrum feeding program. The refractometer instrument costs approximately $250 (USD). In an early study of 185 calves, STP had a good correlation with serum IgG concentration as measured using RID ($R^2 = 0.72$) [98]. Calloway et al., [99] reported that STP concentration test endpoints of 5.0 and 5.2 g/dL yielded the most accurate results in estimating the adequacy of passive transfer as defined by serum IgG ≥ 10.0 mg/ml (sensitivity > 0.80; specificity > 0.80; proportion classified correctly > 0.85). In that study lower or higher test endpoints misclassified larger numbers of calves. Because STP results do result in periodic misclassification of individual calves, the use of STP results as an individual animal diagnostic tool is discouraged. However, when results are interpreted at the group or herd level, STP results accurately reflect the proportion of calves with FPT, thereby making it a very useful on-farm tool for monitoring whether the colostrum management program is succeeding. It is recommended that serum samples be collected from a minimum of 12 clinically normal (not scouring) calves between 24 hours and 7 days of age [6]. Wallace et al., [100] reported that the results of STP refractometry from centrifuge and noncentrifuge harvested sources of serum were highly correlated ($R^2 = 0.95$), so producers can conduct this test on-farm without need of a centrifuge. McGuirk and Collins [6] suggest that a goal is for ≥ 80% of calves tested to meet or exceed a STP cutpoint of 5.5 g/dL. Tyler suggests that ≥ 90% of calves tested should meet or exceed the more accurate STP cutpoint of 5.0 g/dL (Tyler, J. University of Missouri, Columbia, MO. Personal Communication, 2002). If it is determined that a disproportionate number of calves have FPT, then the veterinarian and producer must investigate to identify and then correct the root cause(s) of FPT within the colostrum management program. In addition to periodically sampling groups of calves to assess FPT, producers can also periodically submit frozen colostrum samples to a microbiology lab for

culture. A goal is for a majority of samples submitted to have at total bacteria count of < 100,000 cfu/ml and a total coliform count < 10,000 cfu/ml [6].

Summary

Colostrum management is the single most important management factor in determining calf health and survival. Unfortunately, a significant proportion of North American dairy calves suffer from failure of passive transfer, contributing to excessively high preweaning mortality. There is considerable opportunity for a majority of dairy producers to improve their colostrum management practices, resulting in improved short- and long-term health and performance of the animal. A successful colostrum management program will require producers to consistently provide calves with a sufficient volume of clean, high quality colostrum within the first few hours of life. Colostrum replacers are useful tools if a sufficient quantity of clean, high quality maternal colostrum is not available. Ongoing monitoring will help producers to more quickly identify and correct problems within the colostrum management program.

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Table 1. Composition of colostrum, transition milk and whole milk of Holstein cows [1]

	Colostrum	Transition milk (milking postpartum)		Milk
Parameter	1	2	3	6
Specific gravity	1.056	1.040	1.035	1.032
Total solids (%)	23.9	17.9	14.1	12.9
Fat (%)	6.7	5.4	3.9	4.0
Total protein (%)	14.0	8.4	5.1	3.1
Casein (%)	4.8	4.3	3.8	2.5
Albumin (%)	6.0	4.2	2.4	0.5
Immunoglobulins (%)	6.0	4.2	2.4	0.09
IgG (g/100ml)	3.2	2.5	1.5	0.06
Lactose (%)	2.7	3.9	4.4	5.0
IgGF-I (μg/L)[2]	341	242	144	15
Insulin (μg/L)[2]	65.9	34.8	15.8	1.1
Ash (%)	1.11	0.95	0.87	0.74
Calcium (%)	0.26	0.15	0.15	0.13
Magnesium (%)	0.04	0.01	0.01	0.01
Zinc (mg/100 ml)	1.22	-	0.62	0.3
Manganese (mg/100 ml)	0.02	-	0.01	0.004
Iron (mg/100 g)	0.20	-	-	0.05
Cobalt (μg/100 g)	0.5	-	-	0.10
Vitamin A (μg/100 ml)	295	190	113	34
Vitamin E (μg/g fat)	84	76	56	15
Riboflavin (μg/ml)	4.83	2.71	1.85	1.47
Vitamin B_{12} (μg/100 ml)	4.9	-	2.5	0.6
Folic acid (μg/100 ml)	0.8	-	0.2	0.2
Choline (mg/ml)	0.7	0.34	0.23	0.13

[1] Source: Adapted from Foley, J.A., Otterby, D.E. 1978. Availability, storage, treatment, composition, and feeding value of surplus colostrum: A review. J. Dairy Sci. 61:1033-1060.[12]

[2] Source: Hammon, H.M., I.A. Zanker, and J.W. Blum. 2000. Delayed colostrum feeding affects IGF-1 and insulin plasma concentrations in neonatal calves. J. Dairy Sci. 83:85-92.[101]

Figure 1. Calf Survival by Serum IgG Concentration

Source: National Animal Health Monitoring System. 1993. National Dairy Heifer Evaluation Project. Dairy Herd Management Practices Focusing on Preweaned Heifers. USDA-APHIS Veterinary Services. Ft. Collins, CO. [4]

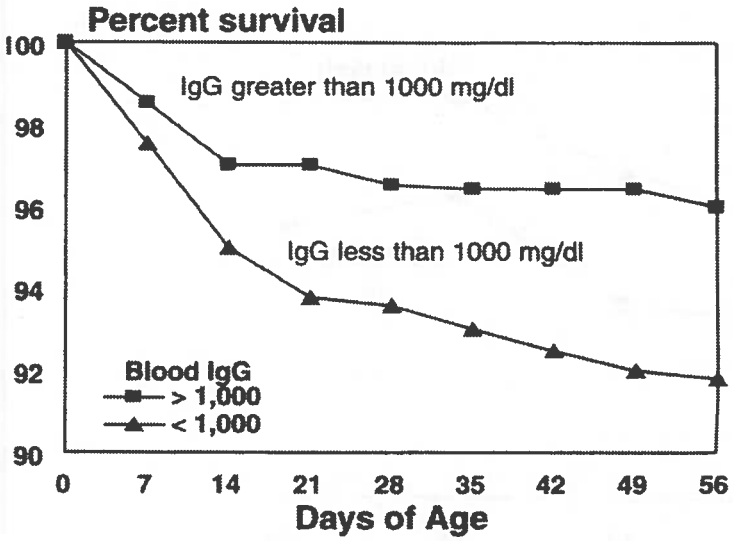
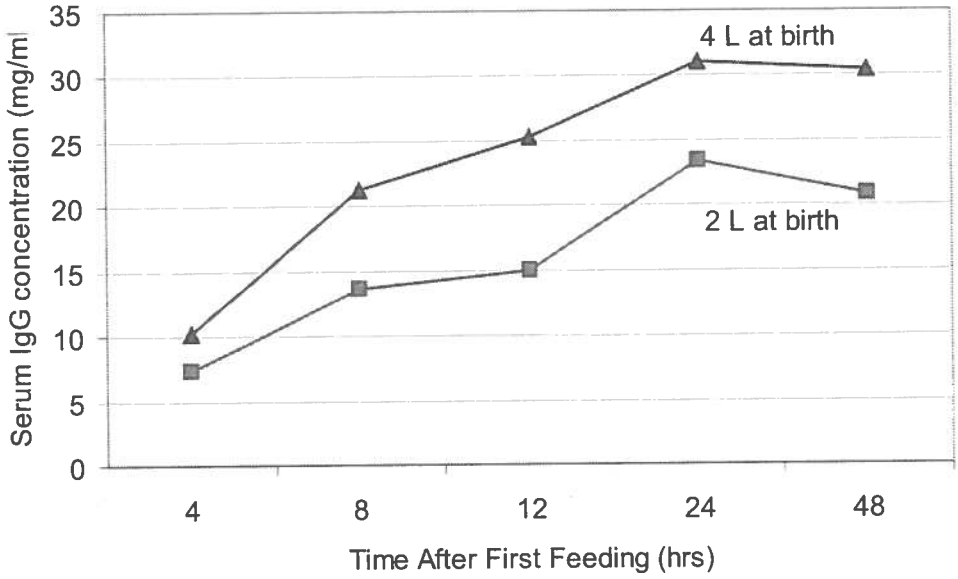


Figure 2. Serum IgG Concentrations in Calves fed either 4L or 2L of colostrum at birth (all calves were fed an additional 2L of colostrum at 12 hours of age).

(Adapted from Morin, D.E., McCoy, G.C., Hurley, W.L. 1997. Effects of quality, quantity, and timing of colostrum feeding and addition of a dried colostrum supplement on Immunoglobulin G_1 absorption in Holstein bull calves. J. Dairy Sci. 80:747-753.)



Calf Management Update: What Does it Mean for Your Farm?

Dr. Ken Leslie was raised on a central Ontario dairy farm. He graduated from the University of Guelph, Ontario Veterinary College (OVC) in 1974, and developed bovine practice skills in Brampton, Ontario. In 1977, he accepted a clinical faculty position at OVC, and subsequently completed his M.Sc. graduate training in dairy cattle reproductive management.

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Dr. Leslie is currently a Full Professor with the Ruminant Health Management Clinic in the Department of Population Medicine, University of Guelph. He has responsibilities for service, teaching, research and extension of dairy health management programs, and has an international reputation for his research and extension in mastitis control and calf health management. His special interests are udder health, dairy calves and transition cows. Dr. Leslie originated the concept of continuing education certificate programs at the University of Guelph, such as the Dairy Health Management Certificate Program. This program has been conducted in full for three cohorts of dairy practitioners, and continues to be held each spring as an annual extension education conference. Dr. Leslie has put a great deal of effort into fostering networks of dairy health management veterinarians, and research workers, on issues relative to dairy cattle health. He is an active supervisor of graduate students and veterinary students with a food animal emphasis in their programs. Through all of these efforts, his primary objective is to foster awareness and interest in the implementation of intensive health management programs for the dairy industry.

Calf Health Management Update: What does it all mean for your farm?

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Maintenance of calf health and well-being continues to be a formidable challenge for dairy farm managers in Canada and across North America. There are a limited number of population-based studies that have reported on calf health and survival. A recent survey of US dairy herds found that 8% of calves die between birth and weaning, and that the incidence of diarrhea and pneumonia during this time period is around 24% and 12%, respectively (NAHMS, 2007). Evidence has slowly been collecting that neonatal disease has many long-term impacts on the growth and productivity of calves, well beyond the period of clinical illness. For example, calves diagnosed with bovine respiratory disease (BRD) in the first three months of life were 2.5 times more likely to die after three months of age. Calves diagnosed and treated for neonatal calf diarrhea before three months of age were 2.5 times more likely to be sold as non-dairy animals, and 2.9 times more likely to calve after 30 months of age (Waltner-Toews et al, 1986a). Furthermore, there is evidence that BRD in neonatal calves has a long-term impact, resulting in greater time to first calving and dystocia rates (Warnick, 1994).

Neonatal calf diarrhea complex is clearly the most prevalent calf health issue in North American dairy herds. Research in Ontario and New York State has clarified the importance of *Cryptosporidia parvum* as a calf health problem. Prevention and therapy of this issue is a major challenge. However, risk factors for this infection, and for its relevance to human health, have been identified. These approaches include evaluation of supplementation of milk replacer for young calves with dried bovine colostrum, and supplementation of first-feeding colostrum with selenium.

A recently completed field study, out of the University of Guelph and University of Minnesota, evaluated the use of novel vaccines and vaccination strategies to better prevent respiratory disease in young calves, to gain these long-term effects. In addition, studies on the use of long-acting antibiotic therapy at weaning have also been completed, with interesting results.

A considerable amount of research on calf health and management has been conducted, and is on-going, at the University of Guelph. These studies have evaluated pain management, vaccination, oral supplementation programs, genetics of calf health, and other investigations. Over the past year, a number of these studies have been completed. Some of these results are presented in this paper, under specific headings for each topic area.

Associations of Calf Morbidity and Mortality with Successful Passive Transfer of Immunity

The neonatal dairy calf is born without immune competence. It is reliant on colostrum to provide nutrients and maternal immunoglobulins (Ig) for protection against disease-causing pathogens (Cortese, 2009). The transfer of colostral Ig from dams to calves has been comprehensively reviewed (Weaver et al., 2000; Godden, 2008). During the first 24 hours of

life, the neonatal calf's small intestine is designed to temporarily allow the absorption of large molecules, such as colostral Ig, across the intestinal membrane (Beam et al., 2009). Failure of passive transfer (FPT) of maternal Ig from dam to calf is common in Ontario (Trotz-Williams et al., 2008). There are recognized associations between success of passive transfer of immunity and decreased morbidity and mortality, as well as improved growth and performance. In a prospective cohort study involving 3,300 Holstein heifer calves in Florida, Donovan et al. (1998) found low serum total protein (serum TP) was a significant risk factor for mortality, as well as for occurrences, age of onset and severity of pneumonia and septicemia. Similarly, Virtala et al. (1999) found calves with low IgG levels had increased odds of pneumonia compared to calves with high IgG levels.

Risk factors for FPT have been identified. The factors for increased FPT include: feeding pooled colostrum, being allowed to suckle the dam, hand feeding of colostrum more than 4 hours after birth (Beam et al., 2009), not being separated from the dam until more than 3 hours after birth (Trotz-Williams et al., 2008), and feeding low volumes of colostrum or colostrum replacer in the first 6 hours after birth (Trotz-Williams et al., 2008; Godden et al., 2009). Colostrum quality can vary significantly among dams and be affected by factors such as breed, age of dam, heat stress, calving season, lactation number, time to collection, dry period length, or preparturient vaccination of the dam (Pritchett et al., 1991; Guy et al., 1994; Nardone et al., 1997; Morin et al., 2001; Gulliksen et al., 2008). Furthermore, feeding higher quantities of colostrum quickly after birth has been shown to be beneficial and improve serum TP values (Weaver et al., 2000; Jaster, 2005; Godden, 2008; Beam et al., 2009).

Getting calves off to a good start with sound colostrum management can contribute to their success of passive transfer of immunity, and reduce their odds of morbidity and mortality in the first four months of life, a University of Guelph study has found (Waalderbos, 2010). The study involved 2,204 newborn heifer and bull calves 1 to 7 days of age from 16 farms in southwestern Ontario. To assess FPT levels in the study, serum TP was measured in blood samples from all the study calves. Serum TP values ranged from 3.6 to 9.7g/dL, with a mean of 5.7 g/dL (SD 0.7). Success of passive transfer was considered anything above 5.2 g/dL. Using this cut-off point, 446 calves (20.2%) had FPT –meaning that this group of calves did not receive adequate transfer of nutrients and maternal Ig via colostrum, to protect against disease-causing pathogens. Furthermore, these calves with FPT were 1.8 times more likely to be treated at least once, and 1.8 times more likely to die before four months of age, when compared with the calves having successful transfer of immunity.

Analysis of serum TP levels revealed that FPT rates varied significantly by farm of origin, with a range from 0% to 60% of calves on farm with FPT. Also, heifer calves were more likely to have higher serum TP concentrations, and less likely to have FPT, than bull calves. To begin to understand what might be influencing these differences by farm and gender various statistical models were run. These analyses showed that passive transfer was associated with first feeding and total amount of colostrum volumes, season of birth and the need for calving assistance.

More specifically, calves that were offered more colostrum at first feeding, and more total colostrum in the first 24 hours of life, had higher serum TP concentrations and reduced odds of FPT. On average, calves in this study were offered 4.0 L (SD 1.2) at the first colostrum feeding and 6.1 L (SD 1.3) total volume in the first 24 hours of life. Colostrum was most commonly offered twice in the first 24 hours (45.4% of calves); while 36.3% of calves were offered colostrum only once. However, 18.0% of calves were offered colostrum three or more times. Heifers were offered on average 0.3 L more colostrum than bulls at first feeding (4.2 L, SD 1.2 vs. 3.8 L, SD 1.1). Most calves received pooled (65.1% of calves) and fresh (67.2%) colostrum. An esophageal feeder was the most common route of colostrum delivery (63.1%), followed by bottle feeding (47.5%), or a combination of the two methods (12.2%).

Calves born in the spring months were found to have the lowest serum TP values, whereas calves born in the fall months had the highest values and lowest risk of FPT. Also, calves that were observed, but unassisted at birth, tended to have higher serum TP levels than calves that were from unobserved calvings. This finding might reflect the time from birth until discovery of the calf and delivery of colostrum. Calves that were delivered as a hard pull, by surgery or were malpresented tended to have the lowest serum TP values and highest odds of FPT.

Supplementation with Dried Bovine Colostrum

As described earlier in this paper, colostrum management is of great importance. In addition to Ig, colostrum also contains protein, non-protein nitrogen, energy, vitamins, and minerals (Quigley and Drewry, 1998). Additional immune components of colostrum include maternal leukocytes, growth factors, hormones, cytokines, non-specific antimicrobial factors (lactoferrin), and other nutrients (Godden, 2008). Providing at least four litres of clean, good quality (high in antibodies) colostrum in the first 6 hours of life is the generally recommended colostrum management practice. In addition to appropriate colostrum management, there is a need for other proactive approaches. One such method that may help to reduce the incidence of diarrhea in neonatal calves, especially those known to have FPT, is the addition of Ig to milk replacer. It is possible that providing calves with additional Ig (during the first few weeks of life) may help to reduce or prevent the development of diarrhea.

Researchers have investigated the potential for Ig to act locally within the digestive tract to provide protection against enteric pathogens. Logan et al. (1974) challenged calves with E. coli to determine if oral administration of specific classes of Ig (IgA, IgM, IgG) provided local protective activity in the intestine compared to both positive calves (colostrum-fed) and negative control calves (no colostrum). The negative control calves did not survive the challenge. Calves given IgA, IgM or IgG orally, not within colostrum, suffered from diarrhea. However, colostrum-fed calves did not show clinical signs of illness. Yet, calves that received IgA contracted more severe bouts of diarrhea than the calves in the IgM and IgG groups (Logan et al., 1974). These researchers concluded that calves receiving oral administration of all Ig classes were provided with local protection in the intestine, compared to calves not receiving any Ig or colostrum. However, providing Ig alone was not as effective as whole colostrum, most probably as a result of the other immune components, such as leukocytes.

In a study conducted on three California calf ranches by Berge et al. (2009), calves were assigned to one of three treatment groups: colostrum-supplemented (using a commercially available colostrum replacer - Bronze Total Colostrum Replacer; Saskatoon Colostrum Company, Saskatchewan), placebo supplement (whey), and unsupplemented control calves. Passive transfer was categorized into adequate passive transfer (IgG ≥ 10 g/L), partial FPT (PFPT) (IgG 3.5 – 9.9 g/L) and FPT (IgG ≤ 3.5 g/L). Using these cutoff points, FPT in this study was 19%. However, FPT is more commonly defined as serum IgG concentrations below 10 g/L. Thus, using this cutoff, FPT in this study is almost 62%, which is much higher than recent reports of FPT rates in the United States (Beam et al., 2009). Calves were supplemented for 14 days, after which they were fed milk replacer or pasteurized hospital milk, depending on the calf ranch. The number of days to first treated diarrhea was reduced in calves supplemented with dried colostrum. This finding was attributed to the presence of local immunity provided by the supplemented Ig. By 28 d of age, colostrum-supplemented calves had gained more weight compared to control calves. However, by 60 d of age no difference in ADG was observed between the groups. This early weight gain difference may be attributed to additional nutrients in the colostrum supplement.

Recently, a study conducted by the University of Guelph, from March 2008 to May 2009, evaluated the effect of supplementing Ontario calves with dried bovine colostrum (DBC) for the first 14 days of life on the growth performance, disease occurrence and general health parameters. It was hypothesized that calves supplemented with Ig in DBC would have higher average daily gain (ADG), higher feed intakes and less disease compared to the unsupplemented calves, particularly for calves with FPT. In total, 120 newborn calves were enrolled on this study. Of these, 39 calves received no IgG supplementation, 41 calves received 5g IgG in DBC per feeding, and 40 calves received 10g IgG in DBC each feeding. Calves receiving DBC in their milk replacer tended to gain more weight during the first week of supplementation than calves in the control group. Calves that weighed less than 41kg at birth gained more per day than calves that weighed more than 48kg at birth. However, overall, treatment did not have an effect on ADG from birth to weaning. In total, calves gained an average of 29, 31.3 and 28.8 kg from birth to weaning in the control, 5g IgG and 10g IgG groups, respectively.

The difference in time to starter consumption, as demonstrated by survival analysis, was statistically different between the 10g IgG in DBC group and the control group. By Day 24 of the study, 100% of calves in the 10g IgG group were consuming 200g of calf starter. In comparison, 100 % of calves in the 5g IgG and control groups were consuming 200g of calf starter at Days 35 and 36, respectively.

Of the 120 study calves, 118 had a fecal consistency score of 2 or 3 during one of the 6 sampling periods, indicating that a significant portion of the calves had diarrhea (loose feces) during the study period. Across all treatment groups, the second and third weeks (7-13 and 14-20 days) of the trial were the periods during which the largest percentage of calves had a fecal score of 2 or 3. Supplementation of IgG in DBC to calves for 14 days did not have an effect on fecal consistency.

Cryptosporidium parvum followed by rotavirus, were the primary infectious agents in this population. Calves in the 5g IgG in DBC group were 4 times more likely to have diarrhea than calves in the 10g IgG in DBC group. Thirty-two percent of diarrheic calves tested positive for C. parvum. Supplementation with DBC did not have an effect on the presence of a pathogen in the feces of calves.

The results of the present study indicate that DBC supplementation may influence ADG in the first week of life and the time to starter consumption. However, overall ADG, fecal consistency, pathogen shedding, and treated illness were not affected by DBC supplementation.

Selenium Supplementation Study

Selenium (Se) content in North American soils is highly variable. Feeds grown east of the Mississippi River and west of the Rocky Mountains typically contain less than 0.01 mg of Se / kg dry matter (NRC, 2001). In Ontario, the majority of the dairy industry is located in regions with Se deficient soils. As a consequence of the low soil Se concentrations, plants that are grown under these conditions contain low amounts of Se. Thus, supplementation of dairy cattle with Se has become common practice. Selenium is widely recognized as an important element for the immune system, and most known for its role in the enzyme glutathione peroxidase. Recently, two textbooks have been published outlining the importance of Se to animal health (Surai 2006; Surai and Taylor-Pickard, 2008). Ruminants, in general, are more susceptible to Se deficiency than other animals (Hafnawy et al. 2010). In dairy cattle, Se deficiency has been associated with a wide range of conditions (Gerloff, 1992). Until recently, the research focus has been primarily the effects of Se supplementation in the mature dairy cow, with the majority of studies focusing on the effects of Se supplementation on reproduction, mammary health, and the chemical form of Se.

Until the recent work of Kamada et al. (2007) and Waalderbos (2010), Se levels in calves has been given little attention. Although beef producers routinely inject calves with a combination of Se and vitamin E at birth, dairy producers have not widely adopted this practice. In general, it has been assumed that calves receive adequate quantities of Se from dams in utero, and through consumption of colostrum and milk. Recently, Waalderbos (2010) showed that Se levels in Ontario calves do not compare well with the laboratory reference interval for Se. In a 2008 study, approximately 1/3 of calves sampled were classified as Se deficient according to the lab reference interval. In calves, Se levels are associated with calf growth rates (Wichtel et al. 1996; Enjalbert et al. 2006) and treatments for morbidity (Waltner-Toews et al. 1986b; Enjalbert et al. 2006; Waldner and Rossengren 2009). This has left researchers to ask if Se levels in Ontario dairy calves are adequate, or if they are limiting calf health and growth.

During the summer of 2009, a field study was conducted to determine the effects of an injection of Dystosel (Se and vitamin E) at birth, on dairy calf health and growth during the preweaning period. This study was conducted on 39 commercial dairy farms located within a 2 hour drive of Guelph, or Kemptville, ON. At the time of discovery of a newborn calf, producers injected calves with 1 mL Dystosel. At a weekly interval, technicians visited each farm to collect

samples and chart the growth of calves on the study. During the study period, producers documented all health and treatment events for each calf. Calves were enrolled at birth, and remained on the study until approximately 7 weeks of age.

In total, 835 calves were enrolled on the study, and there were several significant findings. Compared to control calves, calves that received an injection of Dystosel at birth had higher Se levels in the first week of life. This led to a significant reduction in calves that tested positive for rotavirus between 8-15 days of age. Calves that were injected with Dystosel also had significantly reduced odds of being treated for diarrhea during the 7 week study period.

There was no effect of treatment on average daily gain, infection with *Cryptosporidium parvum*, preweaning mortality, or preweaning treatment other than diarrhea. These results suggest that injection of calves at birth with Dystosel might be a beneficial practice in herds that routinely experience challenges with viral diarrhea pathogens.

Vaccination and Risk Factors for Bovine Respiratory Disease in Dairy Calves

Calf pneumonia, otherwise known as BRD, is an important illness of young dairy replacement heifers, and can have a substantial impact on dairy operations. As described earlier in this paper, BRD can result in serious economic losses. One potential strategy to reduce the incidence of BRD is to vaccinate calves prior to the high-risk period. Pathogens associated with BRD include bovine viral diarrhea virus types 1 and 2 (BVD-1 and BVD-2), bovine respiratory syncytial virus (BRSV), bovine herpesvirus type 1 (BHV-1), and parainfluenza virus type 3 (PI-3) (Radostits et al., 1999). Several other viruses and bacteria have also been implicated, such as bovine coronavirus, Pasteurellamultocida, Mannheimia (Pasteurella) haemolytica, Histophilussomni and Mycoplasma species (spp.)(Radostits et al., 1999). It is common for dairy producers to vaccinate breeding-age heifers and mature cattle with a multivalent viral vaccine against BVD-1 and 2, BRSV, BHV-1 and PI-3. Traditionally, replacement heifers have not been vaccinated until they are at least 6 months old. This practice is due to the notion that the maternal antibodies the calf receives in colostrum prevent the vaccine from being effective. Unfortunately, dairy calves most often suffer from BRD prior to, or shortly after weaning, as the level of protection from maternal antibodies declines. For this reason, some dairy producers vaccinate calves at or before weaning in an attempt to reduce the occurrence of BRD. There has been little field research to evaluate the effectiveness of this practice.

A recent study conducted by researchers at the University of Guelph, in conjunction with the University of Minnesota, investigated the risk factors for BRD in young dairy heifer calves, and the preventive effects of vaccination. The study involved a total of 2,874 heifer calves, from birth until 3 months of age, from 19 commercial dairy farms in Ontario and Minnesota. A wide variety of management styles were represented, from a 40 cow tie-stall herds in Ontario to a 2,400 cow free-stall herds in Minnesota. Colostrum management was very good on many of the herds, although there was wide variation. Overall, only 11% of calves had FPT of maternal antibodies, defined as serum TP below 5.2g/dl when measured between 1 and 7 days of age.

However, on a herd-level basis, 7 of the 19 herds had more than 20% of calves with FPT and several herds had more than 40% FPT.

Overall, 22% of calves were treated for BRD during the study, but this varied between herds from 0 to 44%. Nineteen percent of the calves with BRD had repeated occurrences of the disease and 7% died. Calves with FPT were 1.6 times more likely to have BRD. Getting treated for a disease in the miscellaneous category (including bloat, joint and navel ill, and injuries etc) doubled a calf's chance of having BRD. There was a seasonal effect, with calves born in the spring having an increased risk of BRD. Not surprisingly, calves born on herds with a high occurrence of BRD had a risk of BRD that was 7 times greater than calves from low occurrence herds. Having BRD, or coming from a herd with a high level of BRD, increased a calf's risk of death by 3 to 5 times. In total, 3.5% of calves enrolled in the study died before 3 months of age.

In this population of home-raised calves, vaccination at 2 and/or 5 weeks of age with a commercially available MLV vaccine against BVD-1 and 2, BRSV, PI-3 and IBR[a] did not result in a decreased risk of BRD or death. There are a number of reasons that may explain why vaccination appeared to be ineffective in this study. Maternal antibodies from colostrum have been known to interfere with response to vaccination. Because there was minimal FPT in these calves, it is likely they had high levels of maternal antibodies. Similarly, young calves with naïve and immature immune systems may not be able to mount an immune response to some vaccines. In this study, the average age when calves were treated for the first occurrence of BRD was at 33 days of age. Many calves were not vaccinated until after this time, at 36 to 42 days of age. Thus, any protective effects of vaccination would likely have lagged behind peak disease challenge. Also, vaccination of three quarters of the calves may have reduced disease transmission in both vaccinated and unvaccinated calves, making it seem that both groups were similar, and therefore, the vaccine appeared ineffective. Lastly, it is assumed that the viruses in the vaccine are likely involved in BRD in dairy calves because this is the case in beef calves that get BRD after arriving in a feedlot. However, little research has been done to investigate how often these particular viruses actually infect dairy calves. If BRD in dairy calves is caused by other organisms, rather than the viruses in the vaccine, it would not be of any use in preventing disease. All in all, further research is needed to better understand the causes of BRD in young dairy calves and appropriate methods for prevention.

Overall, the results of this study do not support implementation of multivalent MLV vaccination of calves at 2 and/or 5 weeks of age on commercial dairy farms with a low incidence of FPT. However, even in this population of relatively well-managed herds, the impacts of FPT and calfhood disease on survival and performance were evident. Colostrum management for successful passive transfer should continue to be emphasized for calf health, with the understanding that maternal antibodies reduce the risk of BRD and mortality, but increase the likelihood of apparent vaccine inefficacy. Vaccination may be more effective in preventing BRD in other populations with higher risks of FPT, disease or death, if one or more of the viruses targeted by the vaccine are contributing to BRD in those populations.

Antibiotic Treatment at Post-Weaning Movement

As described several time earlier in this paper, BRD is a major concern when raising replacement heifers because of its high incidence and long-term effects. The objective of this study was to determine the effect of a long-acting antibiotic treatment (Tulathromycin) at post-weaning movement on the incidence of BRD in dairy replacement heifers. A total of 1,395 heifers were enrolled between November 2006 and June 2007 at a commercial heifer raising facility in western New York. Calves were randomly assigned either the long-acting treatment or to a short-acting positive control antibiotic-treated group (oxytetracycline). Calves treated with the long-acting antibiotic were half as likely to need to be treated for BRD in the 60 days following weaning than calves in the control group. Control calves weighed 4.9 ± 0.5 kg less than the study treatment calves after 6 weeks in group housing. However, for calves that were treated for BRD prior to weaning and enrollment on this study, there was no benefit of the long-acting antibiotic treatment. Irrespective of the antibiotic treatment group, calves with clinical BRD in the 60 days following movement weighed 7.9 ± 0.6 kg less than calves without BRD after 6 weeks in group housing.

The Impact of Bovine Respiratory Disease and a Preventative Antibiotic Treatment on Growth, Survival, Age at First Calving, and Productivity Heifers

The calves involved in the previously described experiment on preventive treatment with long-acting antibiotic at first movement to group housing, for the prevention of BRD in the 60 days following weaning, were followed-up on an extension of this study through to first calving and into first lactation. The objectives were to evaluate the long-term effects of BRD and study treatment on growth of heifers until breeding age, age at first calving, incidence of dystocia, milk production and mortality prior to first calving, as well as mortality prior to 120 days in milk. At entry to the breeding barn (382 days of age) calves that experienced BRD weighed 16.0±2.3 kg less than calves that did not have BRD. Also, calves without BRD were 3.4 (long-acting antibiotic) and 1.7 (control) times more likely to survive to first calving compared to BRD calves, respectively. BRD calves were 2/3 less likely to calve before 25 months of age, and 1.5 times more likely to have a difficult calving (calving ease score ≥ 2) at their first lactation. Specific farms showed an impact of BRD on first test milk production, probably depending on farm management factors. However, there was no overall effect on projected 305 day milk production due to BRD. In summary, BRD has many long-term effects on the productivity of heifer calves.

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Calf Feeding Trial Results from the Young Animal Development Centre

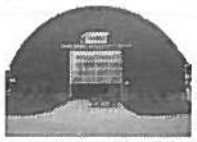
Kathleen is a graduate from the University of Guelph with an undergraduate Science degree majoring in Animal Science, and then a post graduate degree in Ruminant Nutrition. Throughout her university career she worked on various dairy farms performing the every day tasks of feeding calves and heifers while maintaining their health records. In 2006, she started working with Grober as a Nutritionist with a focus on milk replacer formulation, research and development in young animal nutrition.

Kathleen Shore, Nutrition and QA Manager
Grober Nutrition

Kathleen is also leading the Quality Assurance Lab and HACCP program for Grober. In 2009, Grober embarked on a new initiative: The Young Animal Development Centre where Kathleen has been one of the project leaders. Through this initiative, young animals (calves and lambs) have been employed for nutritional and management research purposes in order to provide current and practical information for producers.

Evaluating how to raise calves with success

Kathleen Shore
Grober Nutrition



What we have been doing...

- Since 1974 – dedicated to raising healthy, strong calves
  - Provision of nutrition
  - Modern housing units – welfare
  - Building relationships with academia
  - Delivering product and knowledge to our customers

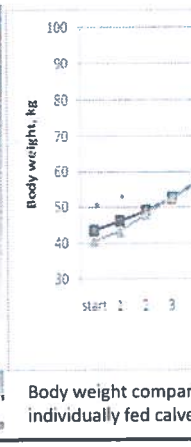
Why we have been doing it ...

- Research brings knowledge
  - Nutrition
  - Behaviour
  - Management
- We want the ag. industry and their farmers to:
  - Gain value from this research
  - Be able to apply new concepts to young animal rearing for optimal SUCCESS

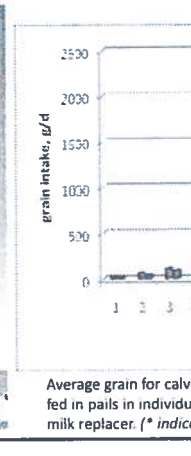
Pearls of 2009

- The exclusive study of calves under 1 roof in pens and in groups

Objective: to evaluate growth, feed intake and health of calves

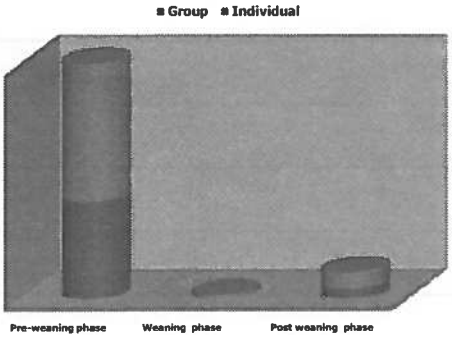


Body weight comparison between group fed and individually fed calves receiving 6L/d of milk replacer.



Average grain for calves fed by automatic feeder in groups or fed in pails in individual pens. All calves were fed 6L/day of milk replacer. *(* indicates significant difference at p<0.05.)*

Therapeutic ratio analysis



Conclusions

- Managed well, calves are successful in groups at a young age
- Beyond weaning, group housing encourages superior growth
- Health events are not necessarily correlated to being in a group

2010 objectives

- Objective: to evaluate calf management techniques and their effect on calf performance and health

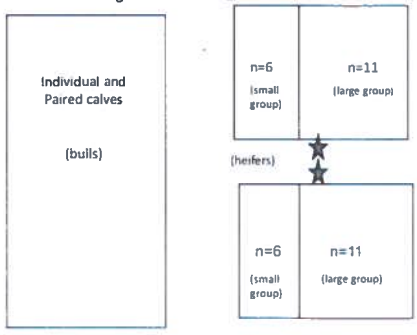
2010 1st calf trial objective …

- ✓To evaluate different group sizes with the same space/calf
  - ✓Differences in feed intake
  - ✓Differences in growth
  - ✓Differences in health

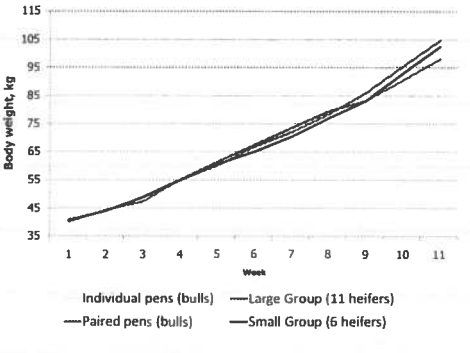
Experimental design

- Milk replacer: 26/18 Grober Excel MR
  - 150g/L built up to 9L/day
- Individual calves fed 3x/d week 1 and then 2x/day
  - Water offered between milk meals
- Group calves fed by machine
  - Water always available
- Hay offered from 4 weeks
- Weight and height measured weekly
- Health assessed daily

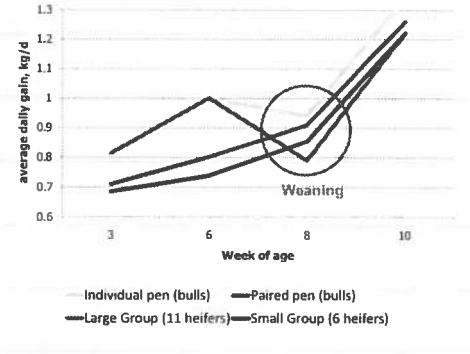
Barn Design for 1st calf trial



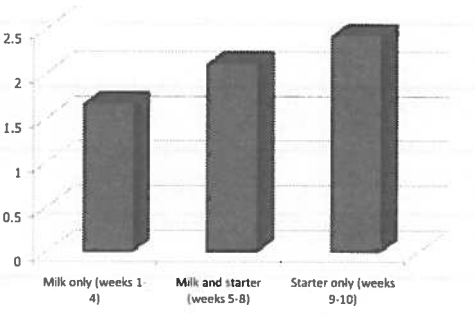
Body weight gains



Daily gains



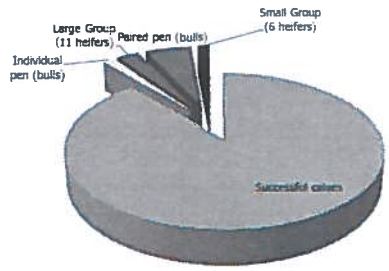
Feed:Gain



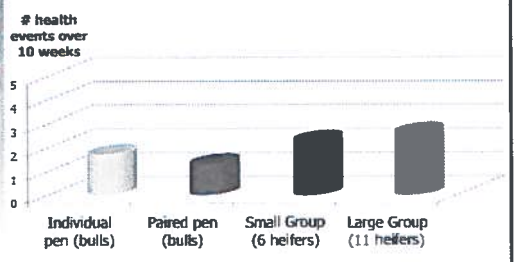
Health

- Evaluate which animals had the most # of health events
  - Score physical observations to decide on treatment
  - Common health events included scours during the first 2 weeks and respiratory problems beyond

The effects of grouping



Health events

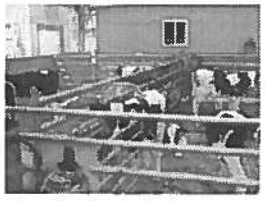


Conclusions

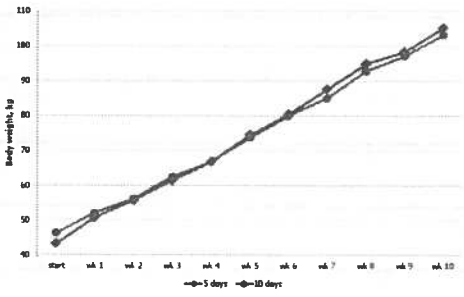
- Space/calf is important to consider
  - the number of calves in a group is not as important under these conditions
- Calves in groups (as seen in 2009) outperform individually housed animals and even paired animals post weaning
- The number of health events are not significantly elevated in grouped calves beyond the first 2 weeks.

2010 2nd calf trial objective …

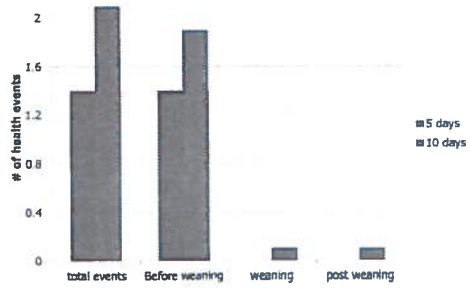
- ✓To evaluate weaning practices
  - ✓Gradually (over 10 days)
  - ✓Abruptly (over 5 days)
  - ✓Grouped in pairs



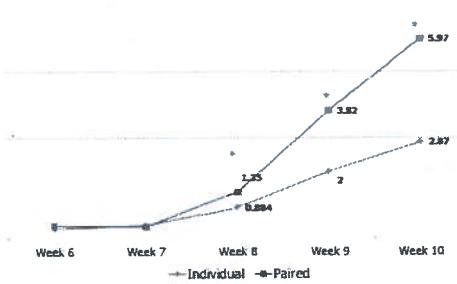
Individual/Paired pens



Individual/Paired pens



Grain intake



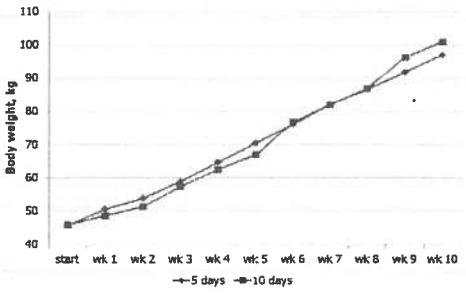
The concept of pairing animals

- May be more successful after the first two weeks
- Is an effective way to encourage grain intake at weaning
  - Reduction in stress?

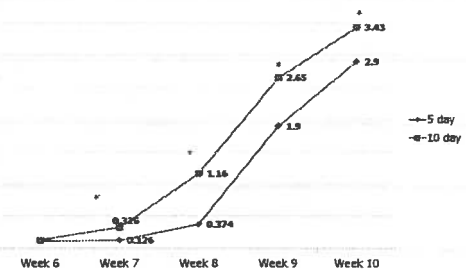
Conclusions

- Weaning can be accomplished over a 5 or 10 day weaning period under these conditions without compromising growth or health
- Grain intakes are encouraged in a group setting earlier at weaning then with calves housed individually
  - This may have a beneficial effect on reduction of stress at weaning and an improvement in rumen development.

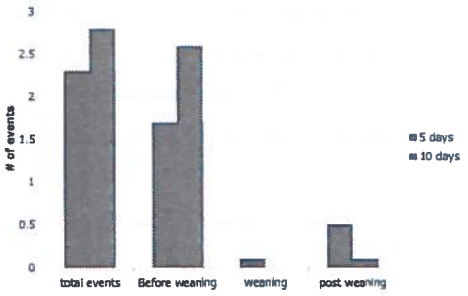
Evaluating the groups (n=9)



Grain intakes



Health Events



Conclusions

- Time to wean does have an effect on grain intake when animals are grouped and fed by automatic feeders
- Time to wean has a positive effect on body weight gain
  - Grouped animals fed by machine may perform better when given a longer time to wean
  - This may be because of the gradual process as opposed to hand fed calves that have a full milk meal taken away

Thank you

In 2011, we will be back at GYADC for another round …

GROBER NUTRITION

Calf Trial Results from the Young Animal Development Center

Evaluating How to Raise Calves with Success ...

The Grober Young Animal Development Center opened its doors in 2009 with the mission of delivering progressive information for raising young animals. Over the past two years, approximately 160 calves and 40 lambs have resided at our Woodstock facility for the purpose of conducting nutritional and management research. We have partnered with others from the industry (feed companies and producers) in order to ensure the research is applicable in today's market.

Within the short period of time these animals are fed milk and introduced to starter diets, their nutritional programs should be optimized and rumen development encouraged in preparation for the next phase of their growth. The challenges of daily farm management can often leave caring for calves as low priority. However, whether raising calves for veal or replacement stock in the dairy herd, the milk fed phase represents the most critical time for establishing health and growth efficiency. The highly digestible nature of milk proteins and the early pre-ruminant state means that milk goes directly into the true stomach (abomasum), is quickly broken down and used for growth and development. In the case of poorly fed or sick animals, the energy will go to maintenance or getting better causing either (a) poor gains if any at all or (b) loss of weight. At this stage of life, grain products cannot replace milk. Moreover, if enough milk is provided to the animal they will continue, once weaned, to be more efficient – that means less grain will need to be fed to gain 1 kg of bodyweight.

Throughout 2009, Grober focused on comparing group and individual calf housing under the same set of environmental conditions and how it related to growth, health and feed intake. We also studied how a conventional milk replacer program delivering 6L/day compared to an optimal feeding program delivering 9L/d. Results of these trials showed us that over the 10 weeks we succeeded in raising a heavier calf in group housing with no significant difference in health challenges or feed intake (grain or milk). Growth of calves was not significantly different for groups and individuals while on milk, it was post weaning (week 9-10) where group calves grew faster than their counterparts in single pens. A heavier calf was also the result of the optimal feeding program with a small reduction in grain intake that did not translate to poorer growth, even post weaning. There were no significant differences in health between the two levels of nutrition.

In 2010, Grober's focus was to look at calf management techniques. Our first group of calves was housed in different group sizes 1, 2, 6, and 11. Each calf had the same floor space ($2.2m^2$). Results showed that group size did not make a significant difference during the milk replacer fed period, but a small difference did appear post weaning (after week 8) such that the large group (n=11) pulled ahead in body weight (Figure 1).

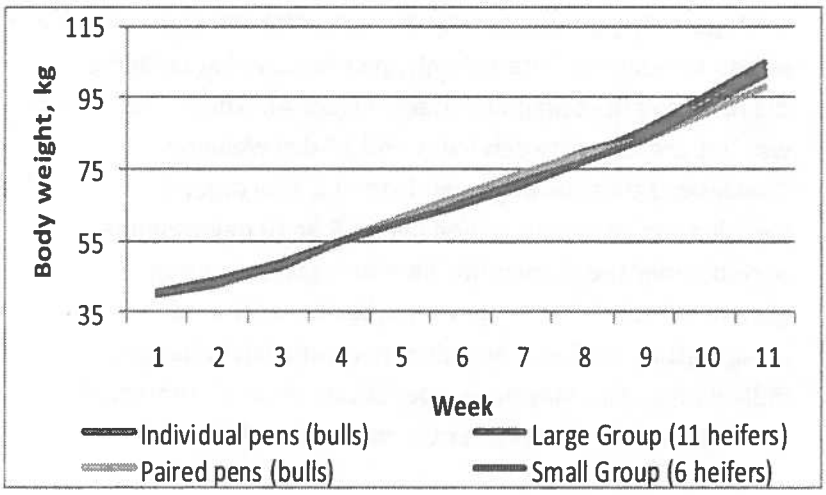


Figure 1 Body weight comparison between different group sizes. *(Note: all results from bulls were scaled down using a conversion factor in order to compare with heifers.)*

When health status was evaluated, significant health events was highest in paired pens (n=2) during the first 2 weeks. Once beyond the first two weeks, paired pens experienced the lowest number of health events (Figure 2). Overall, health events were increased (though not significant) in group pens though body weight gains and feed intake were not compromised. Conclusions that can be drawn from this trial are: (a) space/calf is important to consider, the number of calves in a group even from a very young age is not as important (b) calves in groups (as seen in 2009) outperform individually housed animals and even paired animals post weaning (c) health events are not significantly elevated in group settings beyond the first 2 weeks.

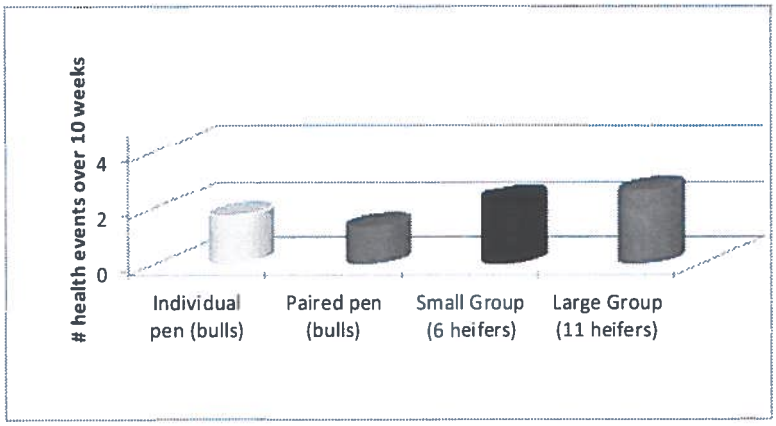


Figure 2 Comparison of the # of health events for different group sizes.

The second trial focused on weaning management; the treatments included calves weaned over 10 days and calves weaned over 5 days. Some individually housed calves within these two treatments were paired at weaning. Calves in individual housing did not show a significant difference in gains when weaned over 5 or 10 days (nor when housed as individuals or pairs) (Figure 3).

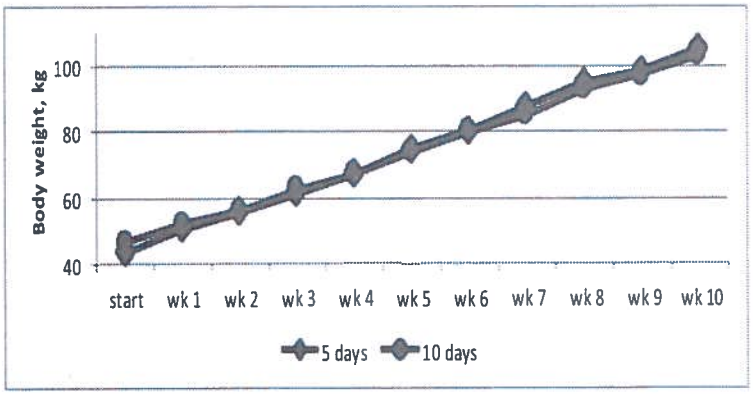


Figure 3 Body weight comparison between groups weaned over a different number of days.

Average daily gain was not significantly different when calves were weaned over 5 and 10 days nor when animals were paired at weaning. Interestingly, pairing calves at weaning did have an effect on grain intake (Figure 4). This effect was not present between 5 day and 10 day weaning. Conclusions that can be drawn from this trial are: (a) weaning can be accomplished over a 5 or 10 day weaning period under these conditions without compromising growth or health and (b) grain intakes are encouraged in a group setting earlier at weaning then with calves housed individually. This may have a beneficial effect on reduction of stress and an improvement in rumen development.

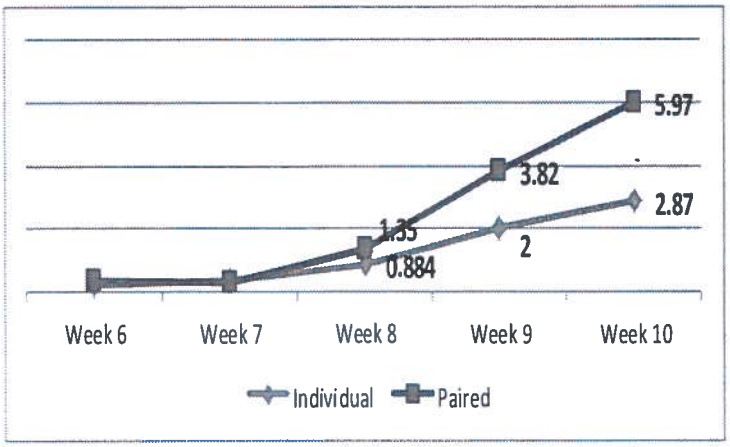


Figure 4 Grain intake (kg/day) comparisons 1 week prior to weaning until 2 weeks post weaning between paired and individually housed calves. *(Weeks 8, 9, and 10 were significantly different.)*

Calves in groups on automatic feeders were evaluated for weaning time only (5 vs 10 days). Body weight differences were not significant although there appears to be a trend towards higher gains in the 10 day weaned calves (Figure 5). Unlike the individually and paired animals, there was a difference in grain intake between the different weaning times (Figure6). Conclusions that may be drawn from this trial are (a) time to wean does have an effect on grain intake when animals are grouped and fed by automatic feeders (b) time to wean has a positive effect on body weight gain. It would appear that grouped animals fed by machine performed better when given a longer time to wean, this may be because of the gradual process as opposed to hand fed calves that have a full milk meal taken away.

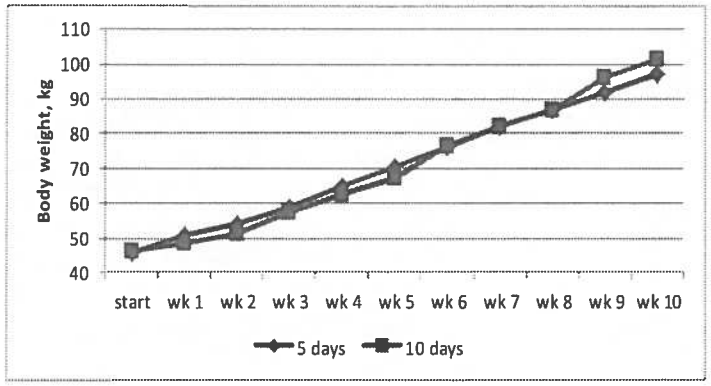


Figure 5 Body weight comparisons for grouped animals weaned over a different number of days.

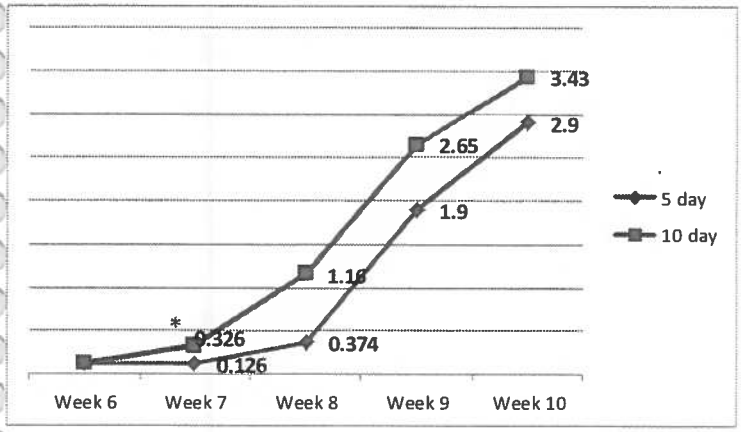
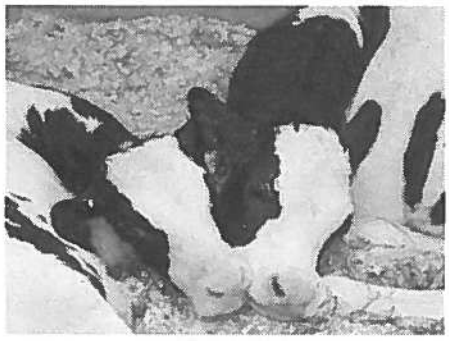


Figure 6 Grain intake (kg/day) for grouped animals weaned over a different number of days. *(Weeks 7, 8, 9, 10 are significantly different.)*

While the producer's goal is to achieve best performance from their calves, it is a combination of nutrition, health and welfare. Understanding management techniques in order to optimize on farm programs will yield a stronger, healthier animal. The careful care and consideration given to young animals on milk will pay off in productivity and ultimately profit. Grober will begin another season of trials starting in April 2011.



Kathleen Shore, M.Sc.
Grober Nutrition
www.grobernutrition.com

Management Practices That Result In Healthier Calves

Brian is a grain-fed veal producer from Drayton Ontario. Brian has been raising veal for over 8 years with his family. As well, Brian brings an extensive background from his time working in the banking and lending sector. Brian is also the Vice President of the Ontario Veal Association.

Brian Keunen
Ontario Veal Producer

Building the Foundation

Dairy and Veal Healthy Calf Conference **2010**

Management Practices For Healthier Heifer Calves

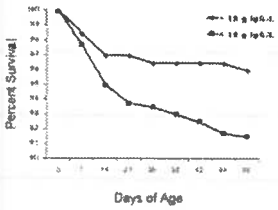
By
Brian Keunen, B.Sc(Agr.) M.Sc.
Mapleview Agri

Healthy Calf Conference
December 8th, 2010

Top 10 Ways to Improve Your Calves

1) Colostrum – Lots and Early
2) Bottle Feeding
3) Lots of Milk
4) Water
5) Grain Early
6) Gradual Weaning
7) Dry Bed
8) Good Air
9) Early Intervention
10) Post weaning program

Colostrum Early



National Dairy Heifer Evaluation Project. USDA:APHIS:VS. Survey represents 1,811 farms in 28 states with 2,177 heifers sampled between 24 and 48 hours after birth.

Colostrum Absorption

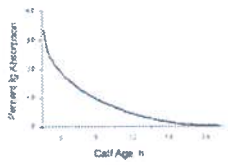


Figure 2. Effect of age of calf on the percent absorption of immunoglobulin through the calf intestine. 1

Animal Sciences Department, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. Published September 2001, reviewed August 2008.

How Much Colostrum

- 2-4 Litres as soon as possible.
- 2-4 Litres after 6 Hours.
- Bottle it or Bag it, just get it in!
- If good clean colostrum is not available use a commercial colostrum replacement product.

Bottle Feeding

- Triggers the esophagal groove to open
- Stimulates saliva production
- Reduces the amount of milk that enters the rumen which can poison the calf
- Sick or gutty calves should be always feed with a bottle.

Lots of Milk

Minimum of 6 Litres of milk or 680 grams of 26-26-17 milk replacer.

Adjust for cold temperatures by increasing volume or concentration

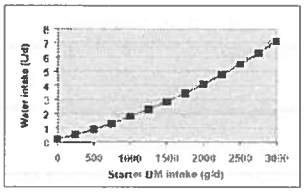
All nutrition in first 3 weeks has to be provided by milk

Water

- Critical to sustain life
- Flushes milk from rumen
- Improves overall health
- Required for grain digestion

Water and Grain

No Water, No grain consumption



J. Quigley, 2001. Calf Note #68. Predicting Water Intake in Young Calves. http://www.calfnotes.com

Gradual Weaning

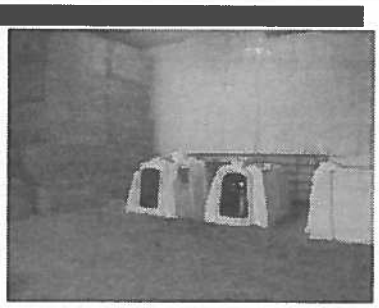
- Our feeding program is to start at 6 Litres and move to 8 Litres (1000 grams) by 14 days.
- Day 35 reduce to 3 Litres twice per day
- Day 49 reduce to 3 Litres once per day
- We do this to encourage reliance on grain

Clean, Dry Environment

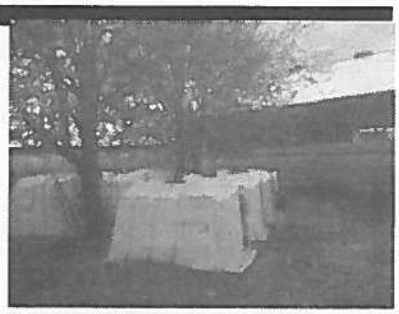
- Lots of Straw or Shavings
- Bale of straw is cheaper that a treatment with Nuflor or Draxxin
- Hutches work well 9 months of the year
- 3 months of the year put them in the drive shed

Quonset Hut Calf Barn in Winter

Straw Storage Half Empty?



Protected Hutches on Wood Chips



Wood Chips Make Good Drainage

Good Air is Critical

Pneumonia usually follow a change in weather because we did not adjust the fan speed when the air cools down and the fans run too slow.

Both not enough and too much air movement causes sick calves.

Early Intervention

- The quicker the treatment the lower the morbidity.
- 12 hours is a long time to wait when a calf has pneumonia.
- 1 early treatment or a series of 5 or 6 if we are 24 hours late and rapid breathing has started. The choice is yours.

Post Weaning Program

- Most neglected part of the heifer raising program
- We remove them from a high energy and protein diet from milk and grain and give them some hay or haylage and expect they to grow.
- Ask your nutritionist for a post wean program!

Questions?

The first 6 months of a calf's life determines the success of the next 2-10 years of your farm.

Invest in your farm's future!

Putting Calf Nutrition to Work

Dr. Drew A. Vermeire is an internationally recognized animal nutritionist working with veal, dairy beef, replacement heifer calves, and beef cattle. He is originally from the Kansas City, Kansas area and has worked throughout the U.S., as well as Canada, and Europe.

Dr. Vermeire earned his B.S. Agr., M.S., and Ph.D. degrees in animal nutrition, from The Ohio State University, and has been involved in animal nutrition, management, and research for more than 25 years. He has been a member of the American Society of Animal Science (ASAS) since 1982, a sustaining member since 1998, and a member of the American Dairy Science Association (ADSA) since 1990. He became a member of the American Registry of Professional Animal Scientists in 1996 and was one of less than 300 nutritionists world-wide to earn the status of Diplomate of the American College of Animal Nutrition in 2001.

Dr.Vermeire lives at Lake Saint Louis, MO with his wife, Laura and their son, Dylan. Dr. Vermeire's daughter, Bonnie, her husband, Troy, and their son, Gabriel live in Lafayette, IN.

Dr. Drew Vermeire, Ph.D., PAS, Dipl. ACAN
Nouriche Nutrition Ltd.

Dr. Vermeire is well known for his development of "The BABY DOLL Program" - the premier management and nutritional program for producing beef from Holstein steers. Dr. Vermeire's company, Nouriche Nutrition Ltd. imports ***Nutrior***™ soluble wheat protein from France for use in milk replacers and Nouriche produces the ***Solutions***® family of products of dispersible premixes, electrolytes and supplements for veal, dairy beef, and herd replacement heifers. Dr. Vermeire conducts research with calves and is the primary or co-inventor of products with five U.S. patent applications pending.

Dr. Vermeire consults with both corporate and producer clients. He has testified as an expert witness in court cases and several state legislative committee hearings. He presently serves as the Chairman for the Veal Quality Assur-

Putting Calf Nutrition to Work

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"The new always carries with it the sense of violation, of sacrilege. What is dead is sacred; what is new, that is, different, is evil, dangerous, or subversive."

-Edgar Varèse

Goals for this Presentation

It has been said that we live in the "information age," but sometimes too much information can be more of a problem than too little information. If a presentation attempts to tell everything, the listeners leave with nothing because of information overload. So, the challenge for this presentation was to distill nutritional principles into a few concise and simple messages. It is not the purpose of this presentation to attempt to tell the audience members what they should do. Rather, it's purpose is to provide some information, ideas to consider, and to provide some tools to help audience members decide what direction they may wish to go based on their own circumstances.

Many people are nostalgic about the Model T Ford and the '57 Chevy, but neither had air conditioning, power steering, power windows, power brakes, or other modern features, which are considered "essential" in today's automobiles. In many ways, our calf management programs have been in place for years, yet are as modern as the '57 Chevy. Maybe it's time for an update! With the time available, we'll cover two areas of calf nutrition and management:

Match the milk replacer program to YOUR goals
Keep more calves alive with a modern scours survival strategy

These two areas have been discussed in other venues in the past, but let's consider our current body of knowledge and see what strategy is best for your operation.

Keep an Open Mind

Albert Einstein is credited with saying the definition of insanity is to continue to do the same thing over and over, but expect a different outcome. Stated another way, if we always do what we always did, we'll always get what we always got. Now, let's explore some nutritional principles, management options, and technologies…

Milk-Fed Compared with Grain-Fed Calves

If your goal is to raise calves with grain, development of the rumen is tremendously important, to enable the calf to digest grain and other solid feeds. If your goal is to raise calves with milk, rumen development is counter-productive.

Table 1. Comparison of Milk-Fed vs Grain-Fed Calf

	Milk-Fed Calf	Grain-Fed Calf
Digestibility of Feed	~ 95%	~ 75%
Manure Solids, % of Intake	< 5%	20-25%
Initial Weight, kg	43.5	38.3
Final Weight, kg	197.0	177.3
Growth Rate, g/day	1066	1043
Feed:Gain	1.87	2.88
Carcass Yield	>58%	<55%

Source: DA Vermeire, Nouriche Nutrition Ltd. Research data (unpublished)

Milk-fed calves are tremendously efficient gaining weight with feed efficiencies of 1.65 - 1.95, digesting approximately 95% of milk or milk replacer and only producing manure solids of less than 5% of their intake. Carcass yield of milk-fed calves is >58% and may exceed 60% at some abattoirs. By comparison, grain-fed calves produce 4-5 times the manure solids because feed digestibility is only 70-75% when fermenting solid feed in the rumen, while milk-fed calves are digesting milk or milk replacer in the intestine. Growth rate can be similar, as shown in table 1, but oftentimes, milk-fed calves will gain approximately 400 grams more per day than grain-fed calves. Efficiency of feed utilization is poorer with grain-fed calves due to lower digestibility and loss of heat, and gasses from rumen fermentation. Finally, carcass yield is much lower from grain-fed calves because the gastro-intestinal system comprises a greater percentage of body weight and the carcass comprises a lower percentage of body weight compared with milk-fed calves.

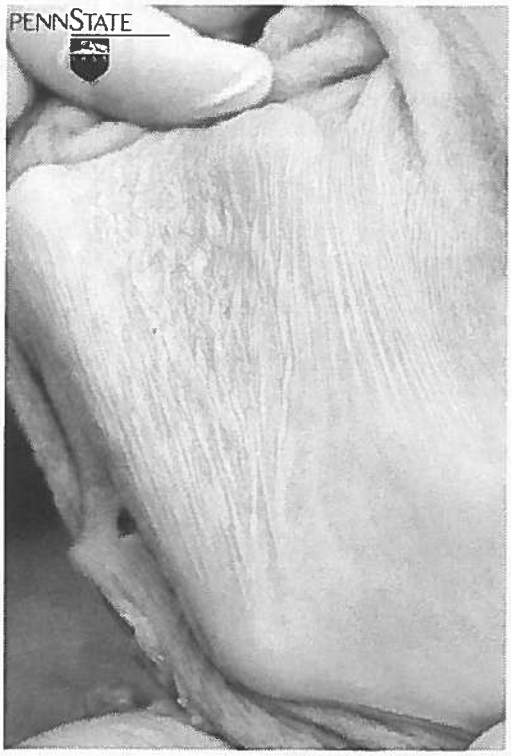
Pre-Ruminant to Ruminant – Grain Intake is the Key

Tremendous changes occur in the digestive system of calves during the first 12 weeks of life. Calves are born as "pre-ruminants" in which the reticulo-rumen is not well-developed and milk is diverted into the abomasum (true stomach) via the esophageal groove. As such, the young calf digests milk or milk replacer in the intestine and cannot digest complex feed constituents. Remember, one identifying factor of all mammals is the provision of milk to the young. Calves are mammals and need milk as their primary source of nutrients until weaning.

Throughout the first 3-4 months of life, calves begin consuming solid feed which stimulates the rumen, reticulum, and omassum to develop. The growth and development of the ruminant system is due to the fermentation products of grain, not due to the age or sex of the calf, and not due to consumption of forages or other sources of fiber (Tamate et al., 1962). The fermentation of starch results in butyric, acetic, and propionic acid which stimulates growth of rumen papillae and thickening of the rumen wall.

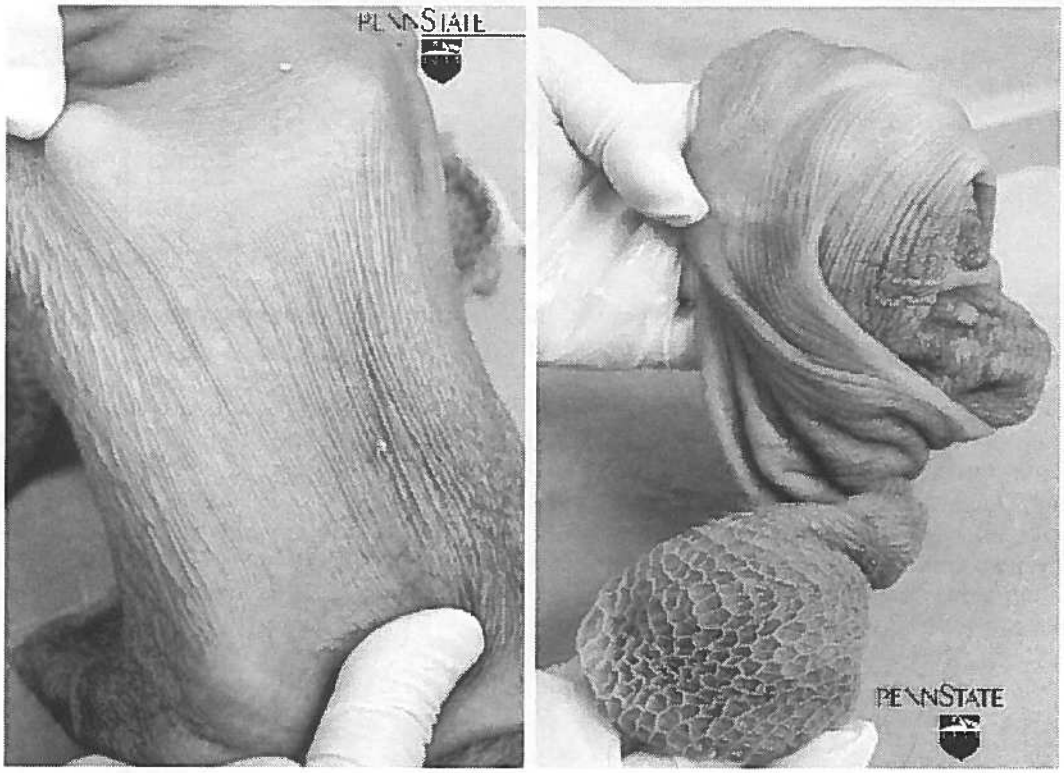
Early consumption and continued intake of grain is required for rumen development. Without rumen development, the calf cannot be successfully weaned from milk replacer to less-expensive starter feed. A key to profitably is early and consistent grain intake to enable early weaning which should be based on the calf's daily starter feed consumption. Greenwood et al., (1997) showed weaning was most effective when 1) at least 21 days old; 2) daily Starter intake is at least 1% of the calf's initial body weight; 3) cumulative total Starter intake is at least 9% of the calf's initial body weight; and 4) calf has gained at least 12% of its initial body weight.

Figure 1. Lining of rumen from calf fed only milk at 6 weeks of age



Source: Dr. Jud Heinrichs, Pennsylvania State University

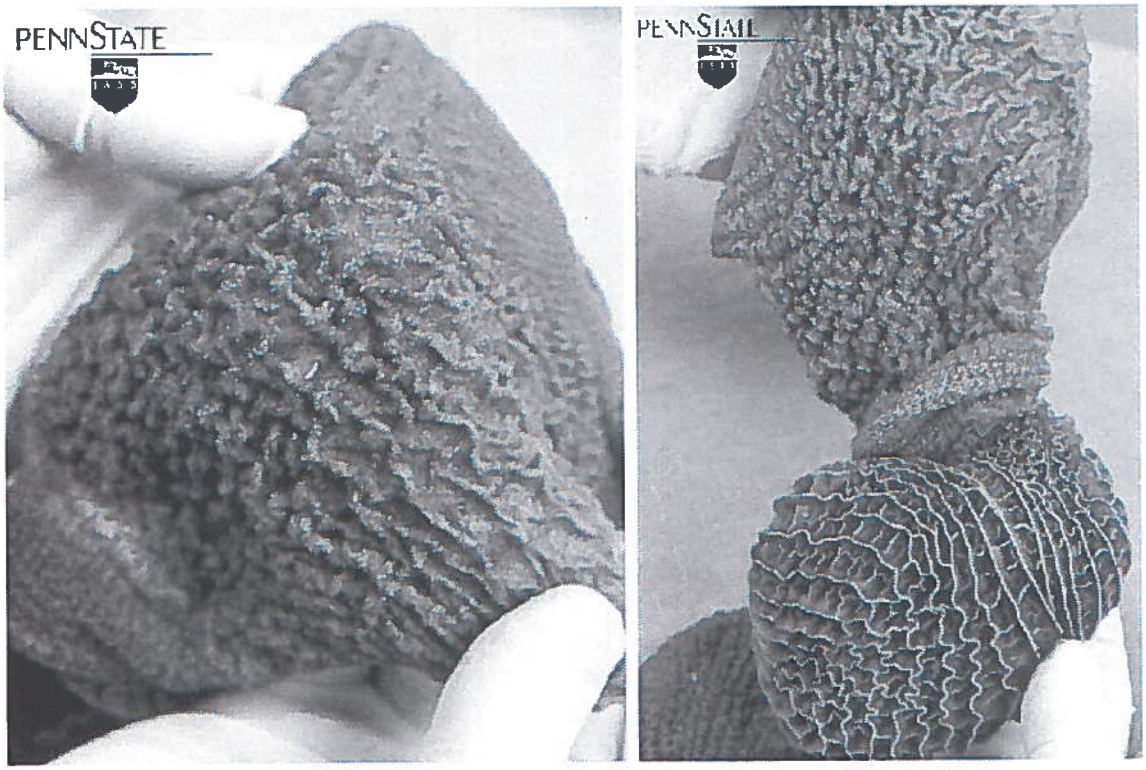
Figure 2. Lining of rumen from calf fed milk + hay at 6 weeks of age



Source: Dr. Jud Heinrichs, Pennsylvania State University

The photos in Figures 1-3 show the differences in rumen papillae development for calves at six weeks of age that were fed milk only, milk and hay, or milk and grain. The differences are clear at six weeks of age, but eventually the rumen papillae develop to look like a shag carpet when the calves are fed grain. By comparison, milk-fed veal calves have papillae that resemble a terry-cloth towel. Each of the thousands of papillae contains a vein, artery, and lymph vessel. Increasing the development of rumen papillae vastly increases the rumen absorptive area. Why are the hands colder in the winter when we wear gloves than when we wear mittens? Because there is more exposed surface area to dissipate heat when gloves are worn compared to wearing mittens. With rumen papillae, the goal is to increase surface area to increase absorption because increased surface area means increased absorptive area.

Figure 3. Lining of rumen from calf fed milk + grain at 6 weeks of age



Source: Dr. Jud Heinrichs, Pennsulvania State University

Three Milk Replacer Programs for Raising Grain-Fed Calves

There are basically three programs in North America for raising calves: the traditional program; the intensified program; and the "Goldilocks" program which is somewhere in between the other two programs.

1. Traditional program – lowest cost per day. The traditional program consists of 450-500 grams per day of a 20% protein/20% fat milk replacer. In other words, this is the "starve the calf and sell the survivors" program. But, this program has the lowest cost per day of the options available. The daily intake of 450-500 grams of milk replacer provides enough energy to meet the maintenance requirement of the calf at ambient temperatures of 18-20° C. This level of energy provides nothing for the calf to gain, only enough for maintenance, and a higher intake is needed when temperatures are colder than 18-20° C. The calf gains weight as it begins to consume grain and weight gain is highly correlated to grain consumption. If your operation is paid a set fee per day to raise a calf - $3/day for example, this system has the lowest cost per day and has been the basis for the American calf industry.

2. Intensified program – highest return-on-investment. This program has been developed following the publication of research from Israel by Bar-Peled et al., in 1997, and subsequent research at several universities and milk replacer companies. With this program, calves grow at a more rapid rate due to higher intake of milk replacer. To meet the needs of calves with the higher rate of gain, protein content in the milk replacer needs to be 28-30% with a lower fat content, typically 15% fat. This program is best suited for dairymen that raise their own calves that will eventually return to join their milking cows. Research and experience has shown that calves fed an intensified program produce approximately 450 kg more milk per lactation when they are older. This program has the highest return-on-investment for the dairyman because of the investment of 1 additional bag of milk replacer compared with a return of 450 kg more milk in every lactation.

3. The "Goldilocks" program – lowest cost of gain. Remember Goldilocks? Today, we'd call her a juvenile delinquent who broke into the 3 Bears' house, ate their porridge, broke their furniture, and slept in their beds. But in the old days, we called her a Fairy Tale character who always concluded that the middle was "just right." The middle program for feeding calves is one in which calves are fed approximately 680 grams of milk replacer per day. At 680 g/day intake, milk replacer composition should be 26-27% protein and 15-17% fat, to meet the calves' requirements for maintenance and growth. With this level of intake, calves consume the same amount of starter feed as calves fed lower intake levels of milk replacer. When milk replacer intake exceeds 680 g/day, grain intake is reduced and weaning is delayed. This program produces calves with the lowest cost of gain and is recommended for dairy beef and grain-fed veal calves.

Table 2. Comparison of Traditional, Intensified, and "Goldilocks" Programs in Grain-fed Calves

	Traditional	Goldilocks	Goldilocks	Intensified
Milk Replacer Intake, g/d	440	660	660	Up to 1090
Crude Protein, % Crude Fat, %	21 21	27 17	27 17	29 21
Days fed Milk Replacer	42	42	28	49
Milk Replacer fed per calf, kg	17.5	26.6	17.4	48.1
Initial body weight, kg 56-day body weight, kg 84-day body weight, kg	45.4 72.1[a] 100.1[a]	45.3 79.1[b] 108.8[b]	46.3 78.6[b] 112.2[b]	45.7 82.2[c] 108.7[b]
Starter Intake, days 1-56, g/day Starter Intake, days 56-84, g/day	724[a] 2,583[a]	728[a] 2,716[a]	908[b] 3,173[b]	667[c] 2,828[a]
Feed Efficiency, days 1-56, gain/feed Feed Efficiency, days 56-84, gain/feed	0.460 0.387	0.501 0.391	0.472 0.379	0.428 0.334

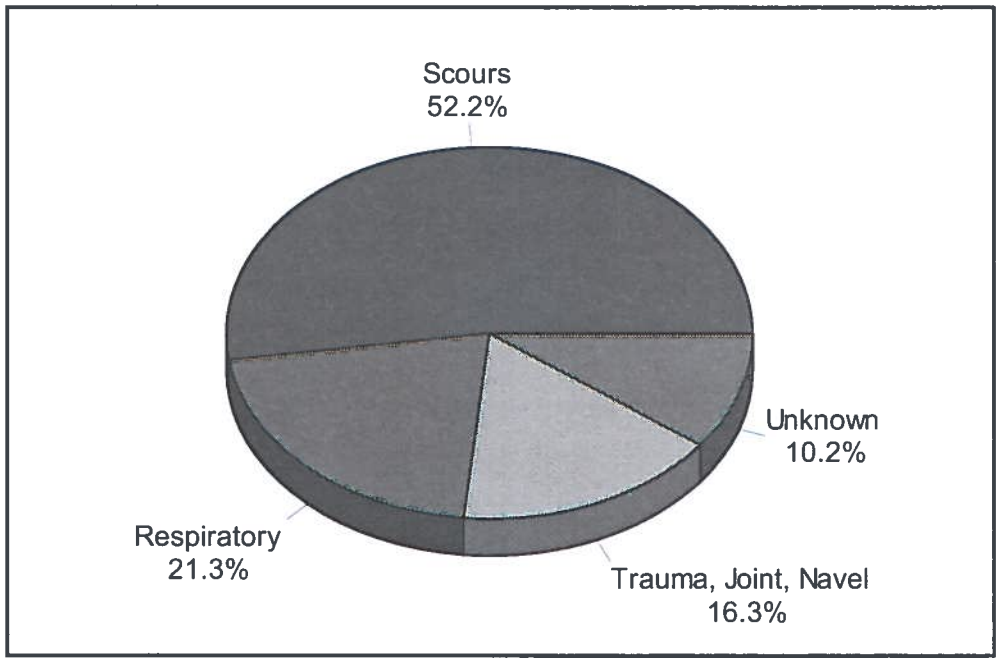
Source: Hill et al., 2010. abc means within rows with different superscripts are different (P<.05)

The research by Hill et al., (2010) in table 2 illustrates the three different systems of producing calves, and also illustrates the effect of weaning calves earlier (Goldilocks weaned after 42 days of age vs Goldilocks weaned after 28 days of age). These data show clearly that compared with the traditional system, the Goldilocks program results in greater body weight gain and increased feed efficiency. Compared with the intensified system, the Goldilocks system results in similar body weight at day 84, but substantially less milk replacer fed to the calves, thus a lower cost of production. The combination of the Goldilocks program with early weaning results in the lowest cost of gain because the amount of milk replacer fed is minimal, plus, the highest body weight at day 84. For replacement heifers, the intensified program has the greatest return-on-investment, but for other grain-fed calves, the Goldilocks program with early weaning is likely the best scenario.

Surviving Scours: Keeping the Calf Hydrated is a Matter of Life and Death!

According to the USDA National Dairy Heifer Evaluation Project, scours is the # 1 calf killer, accounting for 52.2% of all calf deaths between birth and weaning. USDA data showed that 8.4 % of all calves died during this period, meaning that scours were the cause of death of 4.4 % of all calves born. While many countries have lower rates of calf mortality than the USDA data shows, it is certain that calves die because of scours, and with today's economic situation, scours is costing producers more money than ever before. Subsequent USDA surveys have shown little change in the percentage of calves that die due to scours over the nearly twenty years since the first survey was conducted. In other words, we have accepted a 5% death loss due to scours as "normal" and are generally not concerned about it. Other businesses accept shrinkage to mean pilferage or stealing when inventory disappears. But we in agriculture can reduce this rate of loss. In the US, this loss amounts to over $200 million per year!

Figure 4. Causes of calf death – birth to weaning



Source: USDA, 1993

Defining Scours

Scours is a general term for a disease process which results from a disturbance in flow of water, back and forth, between the small intestine and the blood. In a normal gut, as needed, water flows from the blood, into to the lumen of the intestine for the purpose of aiding digestion and back to the blood for the purpose of absorbing nutrients, maintaining blood pH and distributing oxygen throughout the body. Most producers are surprised to learn that a normal, 45 kg calf transports about 100 liters of water from the blood, into the intestine, and back into the blood each day for normal digestive processes! When damage occurs to the intestine, water gets "stuck" in the intestine, resulting in diarrhea or "scours". Fortunately, only a portion of the gut is affected, since it is impossible for a calf to lose 100 liters of water in a day.

Stages of Scours Disease Process

Scours normally progresses through four stages, called Dr. Drew's "Four D's of Scours":

1) Diarrhea
2) Dehydration
3) Depression
4) Death from acidosis

Causes Of Scours

The causes of scours are varied and include exposure to viruses, bacteria, protozoa or various nutritional and digestive problems. These microbial or nutritional causes of scours can often interrupt and damage (usually temporary if corrected quickly) the internal system at the villi and crypt cell level that regulate continuous back and forth flow of water between the intestinal lumen and the body (via the blood).

The normal calf transports about 100 liters (about 26.4 gallons) of water across the gut wall into the intestine and reabsorbs this 100 liters back into the body via the blood, throughout the day.

Diarrhea

When water gets "stuck" in the lumen and cannot get back into the body, this excess water becomes part of the stool and appears as diarrhea. The loss of body fluids via stool leads to dehydration.

Recognizing Symptoms Of Scours

Dehydration 1-5% of body weight – milk (replacer) + 2 liters Generation I, II, or III electrolyte
Not easily detectable
Water loss from transportation, stress, early scours

Dehydration 6-8% of body weight – milk (replacer) + 4 liters Generation II or III Electrolyte
Loose, watery stool
Droopy ears
Slight recession of eyeballs
Lack of skin elasticity of neck and eyelid determined by how fast skin snaps back when pinched <4 sec

Dehydration 9-11% of body weight - milk (replacer) + 6 liters of IV Fluid or Generation III Electrolyte
Eyes clearly sunken into sockets
Lack of skin elasticity of neck and eyelid determined by how fast skin snaps back when pinched >4 sec
Cold extremities due to reduced blood circulation.

Dehydration 12-15% of body weight
Coma
Death

Depression (Symptom of metabolic acidosis – blood pH less than 7.2)
Losing ability to suck and blink
Lack of tactile response-skin twitching and head movement
Lack of response to quick hand movements near eyes
Lack of ability to stand

Table 3. Water Balance for Normal vs Scouring Calf

		Normal Calf	Scouring Calf
Water Gain	Ingested Water	3,461	2,472
	Metabolic Water	227	227
	Total Water Gain	**3,688**	**2,699**
Water Loss	Fecal Water	476	4,318
	Urinary Water	1,252	975
	Insensible Water	812	758
	Total Water Loss	**2,540**	**6,051**
Water Balance	Water Gain	3,688	2,699
	Water Loss	- 2,540	- 6,051
	Net Water Balance	**+ 1,148 ml**	**- 3,352 ml**

Source: Adapted from Phillips et al., 1971.

What Kind of Electrolyte Should I Use?
The differences between Generation I, Generation II, and Generation III electrolytes are quite simple. Generation I contains sodium bicarbonate and Generations II and III contain sodium citrate and/or salts of acetate and propionate. Generations I and II contain dextrose and Generation III contains a special complex carbohydrate. Generation III electrolytes are not available in Canada at this time. It is imperative for the calf to continue to consume milk or milk replacer when it has scours, therefore, the farmer should use at least a Generation II electrolyte that does not include sodium bicarbonate which can interfere with protein digestion in the abomasum by neutralizing hydrochloric acid. No electrolyte contains enough energy to even meet the calf's maintenance requirement, so continuing to feed milk or milk replacer is important.

For the severely dehydrated calf, it is important to feed a Generation III electrolyte and not a Generation I or II product because of the osmotic penalty with dextrose-based products. Osmotic penalty is the pulling of water from the blood into the intestine to balance osmotic pressure due to high concentration of dextrose sugar. The complex carbohydrate used in Generation III electrolytes does not cause osmotic penalty, but it is not available in Canada. Therefore, intravenous fluids must be given to the severely dehydrated calf rather than dextrose solution. Does it make sense to give 1-2 liters of IV fluid to a calf that has lost 8-10% of its body weight? Consider a 45 kg calf has lost 10% of its body weight, and it is obvious that the calf needs 4.5 liters of fluid to break even. The producer that only gives 1-2 liters of fluid will likely find failure as the standard outcome of this practice.

Bottom Line: Take another look at the loss of body weight, above. Dehydration is first visibly detectable when the calf has lost 6% of its body weight, and the calf dies when dehydration reaches 12%. In other words, the calf is "half-dead" when we first see symptoms. The farmer that sees the calf and says to himself, "I'll treat that calf when I finish chores" has a good chance of burying the calf when it is still warm! If the same farmer looked out of the barn and saw smoke and flames shooting out of the house, would he say to himself, "I'll call the fire department when I

finish chores?" NO! He'd drop what he was doing and call the fire department to put out the fire! If a calf producer is going to reduce death losses due to scours, he must change his behavior at this critical moment. At the first sign of dehydration, the calf must be treated! The strongest recommendation is: 1) when a calf has scours, give 1 bottle (2 liters) per day plus milk (replacer); 2) when a calf has dehydration, give 2 bottles (4 liters) per day plus milk (replacer); 3) when a calf has severe dehydration, give 3 bottles (6 liters) per day from a generation III electrolyte or IV fluids. Caution: for severely dehydrated calves, dextrose-based electrolytes cannot be used. One must give fluids with IV for severely dehydrated calves. Treat the dehydrated calf early and often to avoid the calf becoming severely dehydrated.

Time for a Change?

Calf producers can dramatically change the economics of calf production by changing the feeding and management programs they use in growing calves. Among the most dramatic changes, adopting a moderately intensive milk replacer program with early weaning will result in a lower cost of gain and increased calf body weights. Adopting an aggressive electrolyte feeding program in calves with scours will reduce calf death losses and increase profitability.

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Shipping Your Calves Off The Farm: The Do's and Don'ts You Need to Know

Prior to his employment with OMAFRA, he was employed as Chief Inspector of the Ontario Society for the Prevention of Cruelty to Animals (OSPCA). As Chief Inspector, his responsibility was to manage the OSPCA's province wide animal cruelty investigations program. While at the OSPCA, Michael implemented a number of progressive programs to improve the OSPCA's investigations capacity. These programs include significantly enhanced training for new investigators, establishing a dedicated Livestock Inspector position with specific training and knowledge in farm animal care and husbandry practices, and improved investigator standards with formal written policies.

Mike Draper
Livestock Community Sales Act Coordinator / Weigh and Trim Coordinator
OMAFRA

Mike Draper is employed with the Animal Health and Welfare Branch of the Ministry of Agriculture, Food and Rural Affairs (OMAFRA). Michael is responsible for conducting inspections at Ontario's 42 livestock community sales facilities, which auction over 1 million animals each year, and for the enforcement of the Beef Cattle Marketing Act at abattoirs in Ontario.

Marketing Healthy Calves

Regulatory Do's and Don'ts of Marketing Calves

December 2010

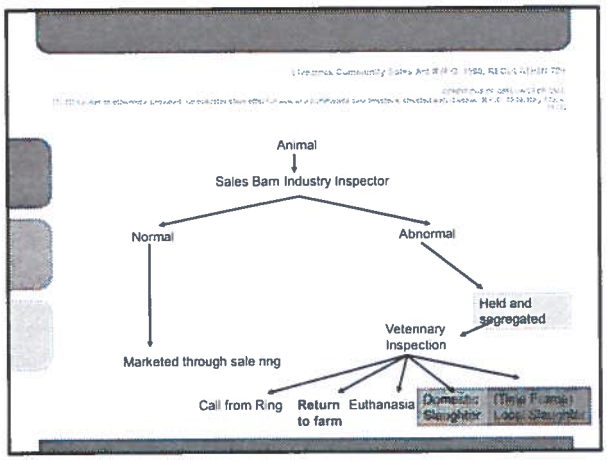
Ontario

Livestock Community Sales Program

- Twenty eight sale facilities are licensed under the Ontario's *Livestock Community Sales Act*.
- OMAFRA provides animal health and welfare inspection at public livestock auctions through contract veterinary inspectors, appointed industry inspectors, and OMAFRA compliance inspectors.
- In 2008, over one million animals were sold through licensed facilities, including 80,000 bob calves.

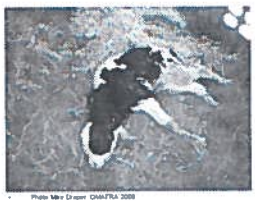
Photo Ed Bailey, OMAFRA 2007

- The *Livestock Community Sales Act* (and its predecessor the *Health of Livestock Act*) came into place in 1952 in order to prevent the sale of diseased livestock and to improve the structural and sanitary conditions of sale buildings.
- Currently, OMAFRA provides veterinary inspection at each sale to provide disease detection / animal health and welfare inspection.

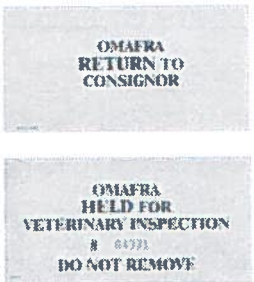


Livestock Community Sales Regulations…

- Prohibits the sale of diseased animals by an auction. (except as permitted by a veterinary inspector).
- Prohibits diseased livestock from being stabled with healthy livestock. This includes trucker / farmer unloading livestock - cannot intermix diseased livestock with healthy livestock.
- Permits the euthanasia of unfit livestock and requires livestock so diseased or disabled the condition is likely to cause their death not to be moved (including to a sale).



OMAFRA veterinary inspector findings…



- **Diarrhea** (with and without fever or dehydration)
- Navel infections
- Pneumonia
- Joint ill
- Moribund calves
- Ring worm (fungal infection)
- Too young (for example yellow soft hooves, unable to stand, wet recent navel cord)
- Poor body condition

Calf Diarrhea

Diarrhea is the most commonly identified issue at auction with young calves

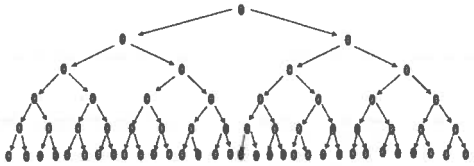
Diarrhea possibilities?
Rota virus, Corona virus, E. Coli, Cryptosporidium, Clostridium Perfingens, Salmonella

Contagious?

Contaminating
trailer mates
pen mates at sale and the facility
calves at veal farm

Schematics of Principles of Disease Spread

Consider spread of a cold if each infected person spreads it to two new people

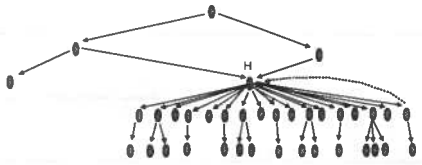


The "reproductive ratio" (R) = number of secondary cases generated per existing case
(in this example R= 2 new cases generated per existing case)

significance of R < 1 outbreak contracts
vs. R > 1 outbreak expands

Ontario

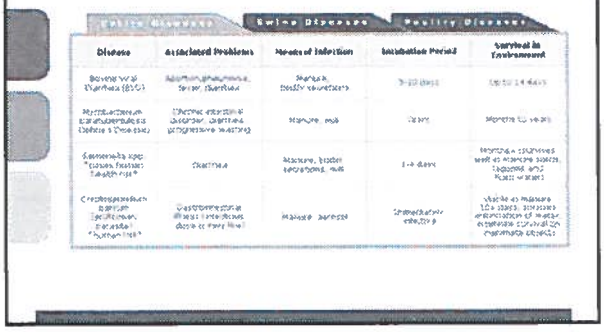
Hubs Can Have Great Influence



With H R = 1.6
Without H R = 0.9

What is Biosecurity ?

Biosecurity is applying a number of practices so that livestock, equipment and personnel that travel from farm to farm, will not spread diseases from one operation to another.



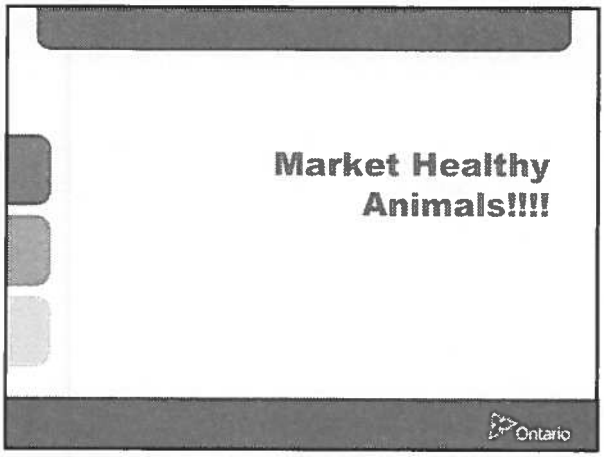
Do's

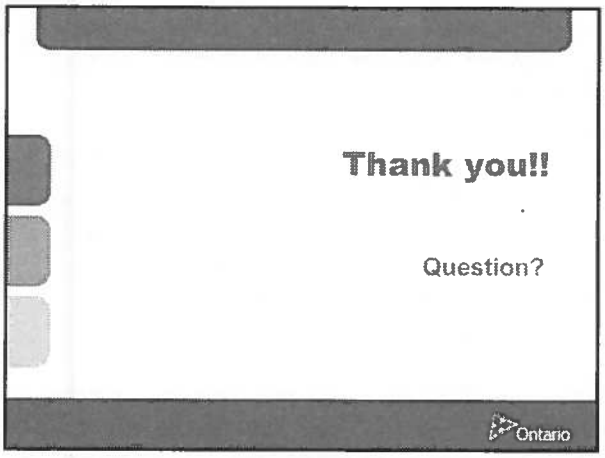
- **Provide excellent husbandry and health management (colostrum, ventilation, dry bedding and feeding).**
- **Practice good navel care .**
- **Feed calves before you ship them. They may have a long journey (in time or travel or both).**
- **Disclose any calves that have not having met drug withdrawal periods.**

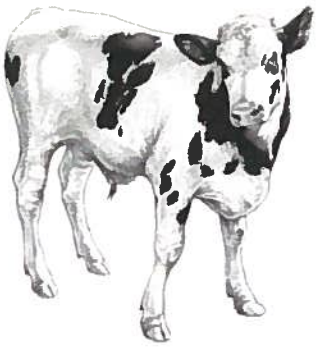
Don'ts

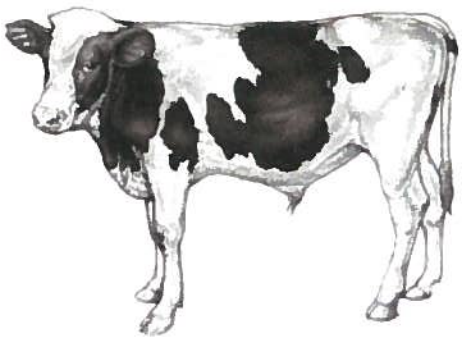
- **Don't sell calves with signs of disease including diarrhea.**
- **Determine cause of weakness in calves…don't ship until recovered.**
- **Don't ship / sell wet calves, specifically in winter months. Insist that truckers have a clean, dry bedded truck.**

Wet calf + cold truck & wind = death


Market Healthy Animals!!!!
Ontario


Thank you!!
Question?
Ontario





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The Ontario Veal Association is a producer organization dedicated to promoting and enhancing a viable and competitive Ontario veal industry through innovation, marketing, advocacy and education.

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