Managing the critical control points of the calf operation

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What are the critical control points?

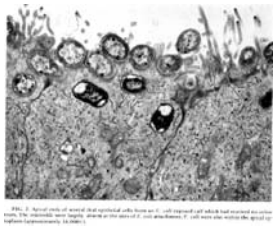
- Successful passive transfer of immunity
- Meeting the nutrient requirements to achieve the genetic potential for calf growth.

Colostrum management - briefly

- Quality - >85% of colostrum with >50g of IgG/liter
  - >22 on Brix Refractometer

- Low bacteria counts
  - <100,000 cfu/ml – standard plate count

Timing – How fast do bacteria reach the small intestine?



It's a race between colostrum and bacteria – from colostrum and environment

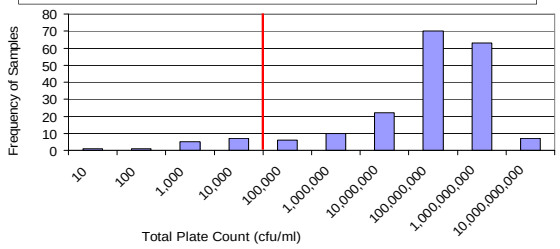
Total Bacteria Counts in Minnesota Colostrum

(Swan et al. 2007. JDSci. 90)

Median TPC = 615 million cfu/ml (73 to 104 billion)

93% of samples > 100,000 cfu/ml TPC

"*We are feeding 'fat-laden' manure*" Rob Trembley, 2006



From - S. Godden

Recent UMN Field Study

M. Donahue, S. Godden 2012

- 1,000 calves / 6 herds
  - ½ fed raw and ½ fed heat-treated colostrum
- Colostrum total plate count and serum IgG – negative
- Colostrum IgG concentration – **positive**
- Heat treatment – **positive** – independent of Total plate count
- Colostrum Total Coliform Count and risk of scours – **positive**.

Characteristics of calf and colostrum

Variable	Fresh (n=518)	Heat-treated (n=553)
Calving ease (1-5)	1.4	1.4
Age at 1st feeding (min)	47.5	50.0
IgG in Colostrum (mg/ml)	63.9	61.1
TPC in colostrum (cfu/ml)	515,000	2,100
TCC in colostrum (cfu/ml)	51,500	90

Donahue et al., 2012

Quantity – Mass of Ig to the intestine

Calf body weight	40	kg
Plasma volume (9% of BW)	3.6	liters
Minimum Plasma concentration	10	g/L
Apparent efficiency of absorption	35	%
Required IgG intake (3.6 × 10 / 0.35)	103	grams
Colostral concentration	50	g/L
Required amount to feed	2.1	L

Figure 1. Estimated colostrum required by a 40 kg calf to achieve minimum plasma IgG concentration of 10 g/L at 24 hours of age.

- Why the overkill in colostrum feeding?
- When are conditions optimal?

88 lb. calf – 2.1 liter ~ 2 quarts ????

It's more than IgG

- Maternal cells in colostrum??
  - Migrate across the calf intestine
  - Found in calf tissues
- Cytokines – small proteins – cell signaling
- Importance?
  - Calves receiving colostrum with maternal cells – fresh vs. frozen colostrum?
    - Activated an immune response sooner
    - Measurable responses to bovine pathogens at day 1.

It's more than IgG

	Colostrum		
	Milking 1	Milking 6	Milk
Dry matter %	24.0	15.3	12.2
Energy Mcal/lb of milk	0.65	0.41	0.30
Protein %	13.3	4.7	3.2
IgG%	8.1	.8	< .2
Fat %	6.4	5.1	3.9
Lactose %	2.5	4.6	4.9

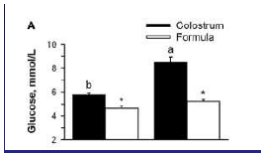
It's more than IgG

	Colostrum		
	Milking 1	Milking 6	Milk
IGF-I µg/kg milk	304	60	< 2
IGF-II µg/kg milk	149	< 1	< 1
Insulin µg/kg milk	65	7	1
Prolactin µg/kg milk	280	-	15
γ-GT µkat/kg milk	374	70	5
Lactoferrin g/kg milk	1.8	-	0.06

Source: Hamman, 2008

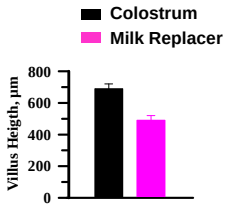
It's more than IgG - Impact on intestine absorptive capacity?

Plasma glucose concentration of calves fed colostrum or milk replacer from birth to 4 days of life.



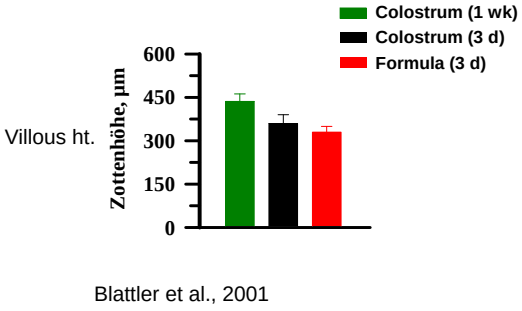
Time after feeding on day 4, h

Steinhoff-Wagner et al., 2010



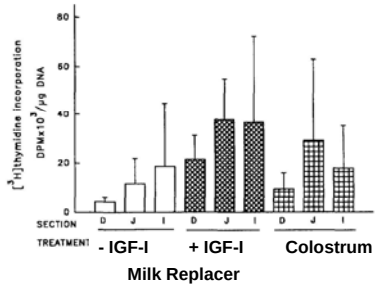
Buhler et al., 1998

Different amounts of colostrum



Blattler et al., 2001

Cell proliferation in small intestine after oral IGF-I feeding



Baumrucker et al. 1994

What about colostrum replacers?

- 250 g of IgG /calf in two feedings from pooled maternal colostrum (MC) or serum derived colostrum replacer (SCR)
  - -120g/day vs. +51.6g/day
- Day 0 – 8 – higher ADG calves fed MC
- > DAY 15 no difference.
- Higher feed efficiency for calves fed MC, most due to first 8 days.

What about colostrum replacers?

- Two studies feeding 150 - 200 g IgG/calf – higher apparent efficiency of absorption for MC vs. SCR. Fidler et al., 2011
- Impact on health? Swan et al, 2007
  - 457 calves on 12 days fed either 125 g of IgG from SCR or 3.8 L of MC.
  - Higher serum IgG and less passive transfer failure in MC calves
  - No difference in morbidity or mortality.

Evaluating colostrum absorption in calves fed MC or SCR

- Serum total protein = 5.0 – 5.2 g/dl ~ Serum IgG >10mg/ml
- Brix classifies about 85% of samples correctly for MC or Colostrum- derived CR
- Agreements not as good with SCR

Take home message – colostrum management

- Why do we fail? ~ 15 – 20% FPT?
- Management
  - Facilities – close up cows, calving environment, newborn housing
    - Timing of fresh cow milking,
    - Colostrum harvest
    - Feeding the new born
    - Growth of bacteria in colostrum / microbial exposure of the newborn.

- Environment – heat and cold stress on colostrum production and calf absorption.
  - Heat stress - reduced total plasma protein, hematocrit, compromised cellular immune function and passive transfer in calves born to heat stressed vs. cooled dams. (Tao et al. 2012)
  - Due to calf or cow?

- Cold stress and colostrum production and calf absorption???
- Is colostrum influence more than IgG?
  - Cellular immunity?
  - Intestinal development – villous height/enzyme development.
  - Insulin?

Management

- Dam's own colostrum best – manage for early intake of low bacteria, high IgG colostrum
- Optimize environment for the dry cow and the calf – moisture, heat and cold stress.
- Utilize colostrum replacers when the above is not optimal.

Nutritional management of the preweaned calf


Meeting the nutrient requirements for growth (?), immune function, ?????

Two concerns in meeting nutrient requirements

- What influences the nutrient requirements of the preweaned calf
- How accurately do we mix and deliver the nutrients to the calf?

Nutrient Requirements

- Body size
- Rate of gain desired??
- Environment
- Management

Nutrient requirements

- Maintenance – Maintain body systems – no growth
  - This is not linear relationship with body size!
  - Smaller calves have more surface area and lose heat more quickly
  - Requirements for maintenance are proportionately higher for smaller calves.
  - Temperature influence on maintenance requirements?

Influence of body weight and temperature on maintenance requirements (Mcal NE/day)

Body weight	Oº F	32ºF	68ºF	Increase in NE
60 lb. calf	1.99	1.58	1.02	95%
90 lb. calf	2.69	2.14	1.39	93%

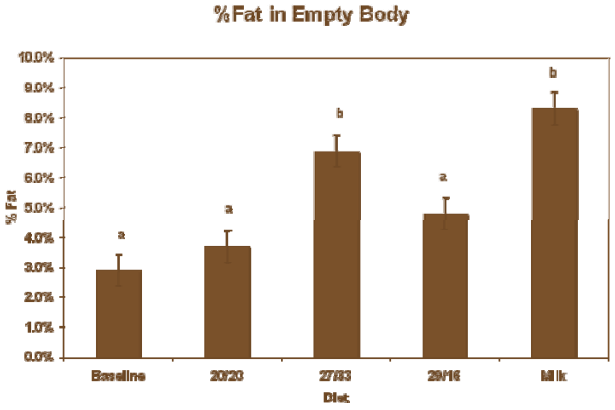
Source: 2001 NRC, Nutrient Requirements for Dairy

Amount of Milk (lb) Required to Meet Maintenance Requirements

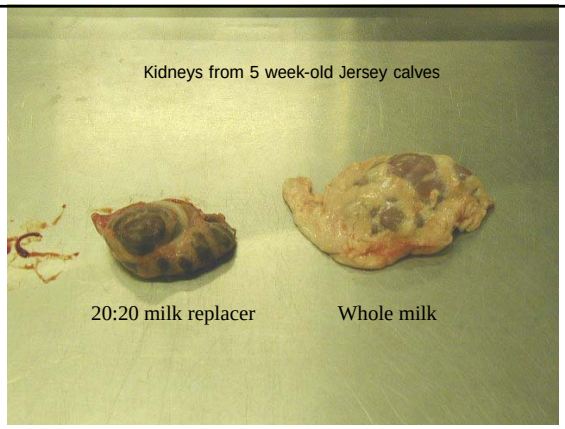
	Temperature º F			
	68	60	32	14
Body weight lb				
55	3.6	4.6	5.6	6.8
110	6.2	7.8	9.4	11.4
165	8.4	10.5	12.9	15.9

Gallon of milk = 8.62 lb.

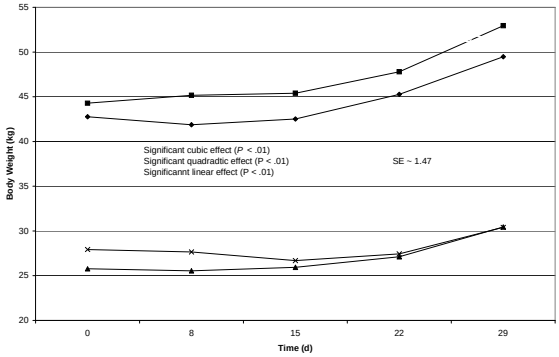
Do Jerseys require more NE/unit body weight?



Baseline = week old, remainder 5 week old Jersey calves



- What rate of gain is desired?
- Week one? Week 4? Week 8?
- What body composition is desired?
  - 3% body fat?
  - 10% body fat?



BW (kg) on d 1 to d 29 of Holstein females (♦), Holstein males (■), Jersey females (▲), and Jersey males (×). Significant breed by time interaction; differences detected on all d. (Mowrey, 2001).

How does management influence nutrient requirements?

- Temperature
- Moisture
- Housing

The newborn calf

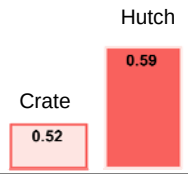
Impact of the following?

- Stress of calving
- Calving environment
- Delay in nutrient intake
- Body composition of the calf - % body fat??

Impact on nutrient status of the calf???

Waste Milk (WM) + Crate **21 Calves**	**Balancer (Bal) +Crate** **20 Calves**
Waste Milk + Hutch **21 Calves**	**Balancer + Hutch** **21 Calves**

Least squares means of weight gain by housing (kg/d) (P<0.02).



K. L. Machado, 2012

Meeting their nutrient requirements

What are we feeding them?

Impact on immune function?

- Newborn Holstein calves fed 50% of maintenance requirements for energy and protein – Griebel et al., 1987
  - Decreased lymphocyte response to stimulation
  - Decreased ability to produce antibody following stimulation.
  - Correction of deficit = normal immune response.

Lb of protein and fat provided by…..

Amount of DM	1 lb	2 lb.	1 lb	2 lb
	lb of protein		lb of fat	
20:20 milk replacer	.20	.40	.20	.40
28:20 milk replacer	.28	.56	.20	.40
Whole milk (8 lb @ 12.5% DM)	.26	.52	.29	.58

Energy allowable gain whole milk vs. 20:20 CMR Week 1

Calf	Whole milk		20:20 Milk	
	68 F	32 F	68 F	32 F
80 lb. calf – week 1 1 lb. DMI	.85 lb/day	.19 lb/day	.64 lb/day	No gain
80 lb. calf week 1 1.5 lb. DMI	1.68 lb/day	1.15 lb/day	1.15 lb. / day	.85 lb. /day

Additional challenges influencing nutrient requirements?
Temperature < 32F
Bedding adequacy?

Quality of incoming milk (Scott, 2006)

Location	PrePasteurization - Aerobic plate count		Fat %		Protein %	
	Low	High	Low	High	Low	High
East	300,000	1×10^8	1.5%	4.5%	2.7%	3.8%
West	26,000	5.9×10^6	1.2%	12.1%	2.7%	4.7%
WI	6,000	7.2×10^7	2.8%	4.7%	2.9%	5.1%

Variation in milk replacer ?

Measure	High value	Low Value
Total plate count - (cfu/ml)	166,000	10,000
Total coliform count (cfu/ml)	12,000	0
DM%	14.0	11.9
Temperature	111	84

Monitor of milk replacer mixing at Va. Tech Dairy
12 p.m. samples – July, 2008.

Additional challenges to young, preweaned calf?

- Training the new born calf to the bucket from the bottle? Interruption in intake?
- Long intervals between feedings
  - Confounded with amount of daily volume
  - Small volume - impact on metabolism during PM
  - Large volume – don't consume all of meal after short interval.

Challenge of feeding more with 2 x feeding?

- Volume per feeding?
- Increase solids level from 12.5% to 17%?

Impact of feeding frequency

- Sockett, D.C., C.E. Sorenson, N.K. Betzold, J.T. Meronek, T.J. Earleywine 2011. J. Dairy Sci. Vol. 94 (Supp. 1):264
- 3 x vs 2x feeding per day
  - 1.8 lb powder 1st week
  - 2.5 lb. powder wk 2 – 6
  - 1.24 lb powder week 7
- Same amount of powder / calf / day

3X vs. 2X daily Feeding – Same Total Amount Daily.

Item	2x Feeding	3x Feeding	P value
BW Gain (1-42 days), kg	25.1	29.8	0.0001
Hip height gain (1-42 days), cm	8.6	10.3	0.0027
Feed efficiency Gain/DM intake, 1-42 days	0.52	0.61	0.0001
Number weaned	32	34	0.3070
Number lactating	28	34	0.0250
Age first calving, days	734	718	0.2278
ME305, milk production, kg	13053	13568	0.2217

- Impact of ingredient equality
  - Milk replacer protein and fat? Digestion
  - Waste or whole milk quality – SCC, antibiotic level, bacteria count, DM%

Question calf feeding management?

- Colostrum management and feeding?
- Where are weak areas in calf management
  - Nutrient intake – amount of solids and consistency.
  - Environment optimized to reduce maintenance expenses.
  - Adjust for environmental temperature changes