

NEONATOLOGY: DAIRY CATTLE



BASICS

OVERVIEW

- A calf at birth is transferred from a nearly sterile environment to an environment containing a multitude of pathogenic and nonpathogenic organisms.
- Neonatal health depends on factors occurring before, during, and after parturition.
- Failure of passive transfer is the failure to ingest adequate volume or adequate quality colostrum.
- Failure of passive transfer can be established via observation of suckling behavior (or lack thereof), and laboratory assessments of passive immunity status such as measurement of serum total protein concentrations or zinc sulfate turbidity testing.
- Modified APGAR (appearance, pulse, grimace, activity, respiration) can be used to assess calf vigor at birth, and is correlated with blood lactate concentrations

Prenatal Care (Conception to Parturition)

Maternal Vaccination

- Strategies should be performed to protect neonates by enhancing disease-specific colostrum immunity and early protection against diarrhea and respiratory diseases (*see Table 1*).
- Preparturient vaccination of the dam 3 to 6 wk pre-calving increases colostrum antibody concentrations

Table 1: *Vaccines That May Be Used During the Dry Period*

Leptospirosis, multivalent
Bovine respiratory syncytial virus, BRSV (modified live or killed virus)
Infectious bovine rhinotracheitis, IBR (altered or killed virus only)
<i>Clostridium</i> , multivalent bacterin/toxoid
Parainfluenza type 3, PI3 (modified live or killed virus)
<i>E. coli</i> (K99) vaccine
Bovine virus diarrhea virus, BVDV (killed virus only)
<i>E. coli</i> J5 vaccine
Rotavirus
Coronavirus

Source: Adapted from LDHM, American Dairy Science Association 1999, p. 399.

- Transfer of live maternal cells from colostrum to neonatal calves enhanced the responses to antigens against which the dams had previously responded, but not to antigens to which the dams were naïve .

Maternal Body Condition Score (BCS)

- Cows should be in good condition throughout the dry period and the lactation cycle: (see Table 2).

Table 2: *Recommended maternal body condition scores (BCS) at various stages of lactation*

Stage of lactation	BCS Range ¹
Calving	3.00–3.75
Peak milk production	2.25–2.75
150–200 days in milk	3.00–3.50
Dry off	3.00–3.75

Source: Adapted from Gearhart et al., 1990.

¹Range: 1(emaciated) to 5 (fat).

Perinatal Care

Care of newborn calf to prevent poor viability and ill health

o Calf resuscitation

- Immediately after birth, calves with mild fetal asphyxia should be hypothermally stimulated by pouring cold water over the head then suspended upside-down for up to a minute.
- Mechanical stimulation should be instituted if not responsive.
- Oxygen therapy is possible but not widely used on commercial dairy farms.
- Initiation of respiration is critical since extended periods without gas exchange lead to acidosis and accumulation of mucus in respiratory tract.
- Prolonged calving may result in fetal hypoxia. Mild to moderate hypoxemia will produce metabolic acidosis.
- Normal calves have a venous pH of 7.34 (7.25–7.45), serum or plasma bicarbonate of 30 mmol/L, and base excess (BE) of 5 mmol/L.
- Acidotic calves may have a pH as low as 7.03 and a base deficit of 18 mmol/L
- Frequent causes of mortality in neonatal calves are dehydration and acidosis.
- Alkalinizing agents (lactate, acetate, gluconate) are used, but bicarbonate is consistently effective in severely acidotic calves. Bicarbonate requirements can be calculated based on base deficit on blood gas measurements or estimated from physical examination findings using the equation:

$$\text{Bodyweight (kg)} \times \text{base deficit} \times 0.5 = \text{bicarbonate deficit (mmol/L or mEq/L)}$$
- Severity of acidosis before 8 days of age can be estimated by physical examination using indicators of body position, strength of suck reflex, and age.
 - A standing calf with a strong suck reflex will likely have minimal base deficit.
 - Calf in sternal or lateral recumbency will likely have a base deficit of ≥ 10 mmol/L
- Severely depressed calves are best treated with IV fluids, and moderately depressed calves with IV fluids if the condition is progressing rapidly in severity.

Umbilical care (prevention of omphalitis):

- Maternal pen hygiene
- Immediate and repeated cord dipping with chlorhexidine
- Removal of calf immediately after birth to clean pen
- Hand feeding colostrum
- Regular checking for navel ill with metaphylactic parenteral antimicrobial therapy

IMMUNITY

- Since neonatal calves are born agammaglobulinemic, passively acquired immunoglobulins (Ig) are essential.

- The bovine placental structure does not allow transfer of Ig between dam and fetus
- Bovine colostrum contains a high concentration of IgG (45 mg/dl).
- Ideally calves aged 24 h have a serum IgG concentration of >10 g/L (10 mg/mL or 1000 mg/dL) to significantly reduce the potential for failure of passive transfer (FPT)

Colostrum Leukocytes

- Mammary secretions contain epithelial cells, macrophages (50% of leukocytes), lymphocytes (20% of leukocytes), and neutrophils (30% of leukocytes) at 1 to 2 days postpartum.
- Newborn calves absorb colostrum leukocytes through the follicle-associated epithelium of the Peyer's patches.
- Colostrum leukocytes appear to contribute to regulation of the cellular aspect of the neonate's immune response.
- Freezing colostrum may destroy leukocytes and diminish protection.

Colostrum Components

Lactoferrin, cluster of differentiation (CD) 14, and cytokines enhance innate and adaptive immune responses:

•Lactoferrin:

- An iron-binding protein product of the transferrin gene family
- Major constituent of the secondary granules of polymorphonuclear neutrophils (PMN) and is found in high concentrations in colostrum and milk during mastitis.
- Higher concentrations in bovine colostrum than milk (1–5 mg/dl)
- Oral lactoferrin is absorbed in calves, but does not alter PMN superoxide production or IgG absorption.
- Direct activity against at least two pathogens, *Escherichia coli* and rotavirus

• CD 14

- CD14 enhances and regulates the inflammatory response to the bacterial cell wall
- CD14 is a glycosyl-phosphatidyl-inositol anchored membrane protein expressed on mature monocytes and macrophages. Lipopolysaccharide binding proteins mediate lipopolysaccharide complexation with soluble CD14.
- Soluble form of CD14 is found in colostrum. Postsuckling calves show evidence of transfer of maternal CD14 to the circulation. Soluble CD14 induces B cell development, and increases antibody secretions by the neonate.

•Cytokines

- Activity of IL-2 is detected in the mammary gland two weeks before parturition, but diminishes in the last week of gestation.
- Antiviral activity in mammary secretions is assumed to result from tumor necrosis factor- α .
- Insulin-like growth factor is found in colostrum at high concentrations and may promote both growth and immune system development in neonates.
- Transforming growth factor decreases rapidly in the milk and almost undetectable by 30 d postpartum.

COMPONENTS OF SUCCESSFUL COLOSTRUM MANAGEMENT

•Breed

- Dairy breeds tend to produce lower concentrations of Ig in their colostrum than beef breeds.
- Holsteins tend to have the lowest concentration of Ig among common dairy breeds, and Jerseys appear to have the highest concentrations.

- Age of dam**

- Older dams tend to have higher Ig in colostrum than first-calf heifers.

- Nutrition in the preparturient period**

- Maternal nutrition may affect colostrum production.
- Suckling calves achieve lower levels of serum Ig on first feed.

- Season of calving**

- Negative effects of heat stress on dry matter intake resulting in nutritional restriction, reduced mammary blood flow resulting in impaired transfer of IgG and nutrient from blood stream to the udder.

- Volume of colostrum produced**

- No predictable relationship between colostrum IgG and weight of colostrum produced at first milking.

- Mastitis**

- < 100,000 CFU/ml total bacteria count
- Discard bloody colostrum, colostrum from sick cows, and cows with clinical mastitis.

- Pooling**

- Increases the number of calves potentially exposed to colostrum-borne pathogens such as Johne's Disease

- Dry period length**

- Producers should not feed colostrum from cows with a short dry period (< 3 wk) even if the colostrums is > 50 g/L IgG.
- Inadequate time for proper response to dry cow vaccines and transfer of those specific antibodies to colostrum.

- Delayed colostrum collection**

- Producers should aim to milk cows within 1 to 2 h after calving.
- Delaying harvest by 14 h can reduce colostral IgG by 33%.

- Time of first feeding**

- Producers should aim to feed a minimum of 3-4 liters of good quality colostrum 1 to 2 h after birth and by 6 h maximum.

- Method of feeding**

- Nipple bottle and esophageal feeders achieve acceptable rates of passive transfer.

- Presence of dam**

- Efficiency of IgG absorption is increased with presence of dam
- To minimize pathogens, calves are removed within 1 to 2 h of birth

- Metabolic disturbances**

- Negative correlation between severity of metabolic acidosis and efficiency of colostrum ingestion
- There is decreased colostral Ig absorption in the first 12 h in calves with postnatal respiratory acidosis associated with dystocia.

- Cold stress**

- Absorption of Ig may be impaired when calves are exposed to extreme cold, possibly due to direct effects on intestinal absorption and transport, and indirect effect ability to stand and nurse.

● **Bacterial contamination of colostrum**

- Fresh colostrum should contain fewer than 100,000 cfu/ml total bacteria count and fewer than 10,000 cfu/ml total coliform count.
- Average bacteria counts in colostrum in dairy herds normally exceed this.
- Calves fed heat treated colostrum are potentially at lower risk for illness

Assessment of Colostrum Quality

- Color and consistency are not good indicators
 - Least accurate when used alone
 - Breed and fat content can affect color regardless of IgG concentration
 - Cooler solution will appear more dense.
- Colostrometer
 - Hydrometer
 - Converts specific gravity to Ig concentration (mg/ml)
 - Poor quality colostrum (yellow or red level exposed during flotation)
 - Green (> 50 mg/ml)
 - Yellow (20 to 50 mg/ml)
 - Red (<20 mg/ml)
- Brix Refractometer
 - Newer method to measure colostrum quality
 - Optical instrument that measures the amount liquid refracted
 - Brix score:
 - $\geq 22\%$ indicates good quality colostrum
 - 18% to 21% can be used for second feedings
 - $\leq 17\%$ should not be used without colostrum supplements.
 - RID IgG concentrations were positively correlated with digital Brix ($r = 0.79$) and optical ($r = 0.74$) refractometers.

Assessment of Failure of passive transfer

- Serum Protein
 - Evaluate at least ten calves before drawing conclusions.
 - Individual animals can sometimes be abnormal for a variety of reasons.
 - FPT if refractometer readings are <5.2 to 5.5 g/dL.
- Zinc Sulfate Turbidity Test
 - Assessment of IgG
 - Inaccuracy
 - Unacceptable high levels
 - If sample exposed to CO₂ or hemolyzed
- Serum gamma glutamyltransferase activity
- Calves with FPT may be treated by the administration of bovine plasma at 20 to 40 ml/kg. Initial rate of administration should be 5 ml/kg and calves should be observed for adverse effects for 30 min including trembling, hives, edema, piloerection, stertorous breathing,

tachycardia and tachypnea. If no adverse effects observed, administration rate can be increased to 10 to 20 ml/kg/h with continuous monitoring.

Vaccination of neonatal calves

- Intranasal vaccination of calves is not affected by maternally derived antibodies.
- Modified-live viral combination vaccine has demonstrated efficacy against BVDV types 1 and 2, IBR, PI-3, and BRSV.

Neonatal Diseases

•Septicemia

- Septicemia affects multiple organ systems, especially the respiratory and gastrointestinal tracts
- *Escherichia coli* causes enteric colibacillosis, characterized by severe diarrhea, and septicemia, an acutely fatal systemic infection.

•Neonatal Diarrhea

- Can be caused by viral, bacterial, parasitic, or dietary insult or a combination. Diarrhea caused by specific organisms is often observed at specific ages of the neonate,

- Viruses:

- Rotavirus (4–14 d)
- Coronavirus (4–30 d)
- BVDV (any age).

- Common bacterial infections are:

- *Clostridium perfringens* (< 10 d)
- Enterotoxigenic *Escherichia coli* (1–4 d),
- *Salmonella typhimurium* (any age).

- Parasitic infections:

- *Cryptosporidium parvum* (7–28 d, possibly older),
- *Eimeria bovis* (> 3–4 wks)
- *Giardia* spp. (not thought to be major pathogens in calves).

- Nutritional aspects:

- Overfeeding
- Inadequate sanitation of equipment
- Feeding of waste milk
- Poor-quality milk replacers
- Deliberate underfeeding of healthy calves predisposes calves to diarrhea.

- Calves with diarrhea usually have a partially compensated metabolic acidosis with:

- Decreased pCO₂
- Negative base excess
- Low blood pH

Neonatal Nutrition Requirements

- Neonatal calves must have a good source of energy; milk replacers should contain a minimum of 15% fat on a dry matter basis, but may contain more than 20% (see Table 3).
- High levels of fat are included in milk replacers to provide extra energy for growth, and inclusion of fat may tend to reduce severity of diarrhea.

- Stores of B vitamins are low in neonatal calves so need to be fortified in milk replacers (see Table 4).

Table 3. Recommended Nutrient Content of Milk Replacers

Nutrient	Amount
Metabolizable energy (Mcal/lb)	1.71
Crude protein (%)	22
Ether extract, fat (%; minimum)	15 ^a
Vitamin A, K (IU/lb)	3.682 ^b
Vitamin D (IU/lb)	245 ^b
Vitamin E (IU/lb)	20.4 ^{b,c}

^aNational Research Council, 1989.

^bNational Research Council, 2001

^cReddy. 1987.

Table 4. Concentrations of B-complex vitamins required in milk replacers¹

Vitamin	mg/kg of DM
Thiamine	6.5
Riboflavin	6.5
Pyridoxine	6.5
Pantothenic acid	13.0
Niacin	10.0
Biotin	0.1
Folic acid	0.5
B12	0.7
Choline	1000

¹ Chapter 10. Nutrient requirements of the young calf. National Research Council. Nutrient Requirements of Dairy Cattle Seventh Revised Edition, 2001.

- Although vitamins A, D, and E are necessary components of the calf's diet, some milk replacers supply excessive amounts of these fat-soluble vitamins. In addition, vitamin E appears to be immunostimulatory at levels of 125 IU/day.



MISCELLANEOUS

SEE ALSO

Body Condition Scoring Dairy Cattle (www.fiveminutevet.com/ruminant)

Bovine Viral Diarrhea Virus

Infectious Bovine Rhinotracheitis

Parainfluenza-3 Virus

ABBREVIATIONS

- BCS = body condition score
- BE = base excess
- BRSV = bovine respiratory syncytial virus
- BSE = bovine spongiform encephalitis
- BVDV = bovine viral diarrhea virus

- CD14 = cluster of differentiation 14; cell-surface molecule
- IBR = infectious bovine rhinotracheitis
- IgG = immunoglobulin G
- IL-2 = interleukin-2
- PI3 = parainfluenza 3
- PMN = polymorphonuclear neutrophils

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