

Critical Calf Care

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Abstract

Most newborn calf deaths occur prior to weaning, and perinatal mortality that occurs within 48 hours of birth is an increasingly important problem. High-risk calves are delayed in head righting, sitting, and standing attempts. They may be meconium stained, have had an assisted delivery, or been born with a short or prolonged gestation. Without critical care, many of these calves adapt poorly and are at risk for poor colostrum absorption, hypoglycemia, hypothermia, respiratory acidosis, disease, and death. Neonatal resuscitation, oxygen delivery, and fluid administration improves survival rate. Colostrum delivery, clinical monitoring, intravenous catheter placement and maintenance, supportive care, and the implementation of effective treatment protocols performed by trained veterinary technicians provide added value to the large animal veterinarian by enhancing the survival and health of calves.

Résumé

La plupart des décès de veaux nouveau-nés se produisent avant le sevrage, et la mortalité périnatale survenant dans les 48 premières heures est un problème qui prend de l'ampleur. Les veaux les plus en danger tardent à redresser la tête, à s'asseoir et à se mettre debout. Ils peuvent être teintés de méconium, avoir dû subir un vêlage assisté, ou être nés avant ou après terme. Sans soins essentiels, un grand nombre de ces veaux s'adaptent mal et risquent de souffrir d'une ingestion de colostrum insuffisante, d'hypoglycémie, d'hypothermie, d'acidose respiratoire et de maladie, ou de mourir. La réanimation néonatale, l'apport d'oxygène et l'administration de fluides augmentent le taux de survie. De même, l'apport de colostrum, le monitoring clinique, la pose et le maintien d'un cathéter intraveineux, les soins continus et le respect de protocoles de traitement efficaces par des techniciens vétérinaires entraînés, tout cela est d'une aide précieuse aux vétérinaires de grands animaux et favorise la survie et la santé des veaux.

Introduction

The greatest risk period for dairy calf death occurs before weaning. Despite some improvement in the reported calf mortality rate between 48 hours of age and weaning within the last five years,⁷ perinatal deaths,

defined as those occurring within the first 48 hours of life, is a problem of increasing magnitude and may be prevented with better identification of, and attention to, at-risk calves. The causes of death among calves in this age group, which include combined respiratory and metabolic acidosis, hypothermia, hypoglycemia, parturient trauma from dystocia, hypoglobulinemia, congenital conditions, sepsis or systemic disease, and blood loss, can be prevented with prompt attention and the delivery of critical care. With improved knowledge, equipment and skills, critical care can be delivered on the farm or at the veterinary clinic or hospital. The skills and training of veterinary technicians are uniquely suited to implement the veterinarian's protocols for resuscitation, respiratory assistance and circulatory support, fluid administration, supportive care, and monitoring that can save calves and enhance the future performance and productivity of these replacement animals.

Clinical Signs Exhibited by Calves with Critical Care Needs

Within minutes of delivery, a normal calf is head righting and works its way to sternal recumbency within five minutes. Shortly thereafter, it begins making attempts to stand, and most are standing within an hour of a normal vaginal delivery. The selected clinical parameters of newborn calves shown below correlate well with vitality⁴ and are useful to assess newborn calves.

- Rectal temperature: 102-103°F (38.8-39.4°C) right after calving, stable at 101-102°F (38.3-38.8°C) within one hour
- Heart rate: 100-150 beats per minute, rhythm is regular, pulse is strong
- Respiratory rate: 50-75 breaths per minute, primarily thoracic effort
- Hair coat appearance: Placenta covered but not discolored
- Head, limbs and tongue: No swelling, edema or discoloration
- Mucous membranes: Pink, moist and refill time < 3 seconds
- Responsiveness: Responds to stimulation with head shaking and movement of limbs, strong corneal reflex, suck reflex is present
- Muscle tone: Able to maintain sternal recumbency by five minutes, attempts standing within 15 minutes, standing by 60 minutes
- Suckling: Ready to nurse within two hours

Some of the most important clinical signs that alert you to a calf requiring critical care are obtundation, hypothermia (<101°F; 38.3°C), bradycardia (<80 bpm), dilated, unresponsive pupils, inactivity or flaccidity. While not considered a sensitive indicator of cardiopulmonary arrest in small animals,⁶ cyanotic mucous membranes or prolonged capillary refill time can be an indication of the need for circulatory support in newborn calves. Tachypnea (>75 bpm) with expiratory cycle accentuation, an abdominal lift or snap, or expiratory grunting may indicate the need for respiratory support.¹ An erratic breathing pattern, with long periods of primary or secondary apnea should also be viewed as a need for critical respiratory support in the young calf.

Not all of the clinical parameters or clinical signs discussed above need to be present to initiate a resuscitation protocol or begin the procedures for critical care. The initial evaluation is abbreviated so that prompt intervention is initiated. Once the critical need calf has been stabilized, a complete physical examination by a veterinarian can help establish the primary cause, a prognosis, the need for further diagnostic testing, and/or the plan for longer term care.

Equipment, Supplies, and Drugs

The lists below can serve as a guide. Many items of regional availability and familiarity may not be included. The on-farm inventory will differ from the hospital or veterinary clinic inventory.

Supplies

- Dry towels
- 4"X4" gauze sponges
- Alcohol
- Betadine scrub
- Adhesive tape and bandage material for catheter maintenance
- Suture material for catheter maintenance

Equipment

- Rectal thermometer
- Stethoscope
- Compressed air, oxygen or an Ambu bag
- Suction device, aspirator or resuscitator
- Face mask
- Endotracheal tubes (5.5-11 mm; most common 7-8 mm)
- Needles (20-gauge X 1 or 1.5 inches; 16-gauge X 1.5 inches if needle is used to administer hypertonic saline solution)
- Syringes (primarily less than 5.0 cc syringes needed, but 60 cc syringes for hypertonic saline solution administration)
- Intravenous catheters

- Intranasal catheters
- Esophageal feeder
- 3 or 4 qt bottles and nipples
- Colostrum or colostrum replacement products

Drugs

- Navel dip – iodine or chlorhexidine
- Hypertonic saline solution
- Epinephrine (1:1,000)
- Dexamethasone
- Flunixin, meloxicam or another injectable non-steroidal anti-inflammatory drug
- Magnesium sulfate solution
- Vasopressin
- Atropine
- Dextrose
- Vitamin E/Selenium

Newborn Calf Resuscitation

Many of the calving events that are difficult and prolonged due to assistance and/or slow labor result in calves that must be resuscitated after delivery. Without the veterinary technician or veterinarian in attendance, many of these calves account for the growing problem of stillbirths in the dairy industry. On-farm training by a veterinarian or veterinary technician can result in improved awareness of high-risk pregnancies, such as calving age < 22 months; body condition score \geq 4; days carrying calf < 274 or > 288; small cow/large calf combination or sick calving cow are some examples. It is important to set clear-cut guidelines for supervision of these cows prior to and during delivery. The procedures for calving intervention that include timing, preparation, method, and when to call for help should come from veterinarian (<http://www.cvmb.colostate.edu/ilm/proinfo/calving/notes/whentocallforhelp.htm>) and be trained, monitored or delivered by the veterinary technician. Some respiratory stimulation and assistance can be initiated during delivery once the thorax of the calf has emerged.

After delivery, calves that are not breathing, are dyspneic, remain in lateral recumbency or are flaccid must be attended to immediately. Determine that there is a corneal reflex and that the corneas are not cloudy. Examine the navel and make sure that it is not bleeding. On the farm, stimulate the calf to breathe, using vigorous stimulation around the head, ears and mouth with a dry towel to stimulate breathing. Tracheal compression to stimulate a cough, pinching the nasal septum between two fingers placed in the nose of the calf or applying pressure to the muzzle have been advocated to initiate coughing and breathing reflexes. More recently, the practice of pouring cold water down the calf's ear or over its head has been shown to have a positive impact

on respiratory function.⁸ If mechanical assistance is needed, available, and desired, the use of a resuscitator, masks, and endotracheal tubes in newborn calves has recently been described.⁵

Pharmacologic respiratory stimulants such as doxapram have proved to be of minimal benefit or potentially harmful.^{4,6} Even with some transient apparent improvement, it is believed that doxapram reduces cerebral blood flow, while increasing cerebral oxygen requirement and consumption. Atropine (0.04 mg/kg) and epinephrine (0.1 mg/kg 1:10,000) may also have transient benefits for cardiopulmonary support in these calves, especially those with bradycardia, but it is rare that we use either drug unless hypertonic saline solution (HYSS) administration is unsuccessful. We use a 16-gauge, 1.5-inch needle to gain venous access for HYSS administration as it is rapidly administered over a period of three to five minutes. Just prior to giving a 3-5 ml/kg dose of HYSS, 5 gm of dextrose is administered as a bolus (10 ml of 50% dextrose) to eliminate temporary concern for hypoglycemia. After HYSS administration, two quarts of warm water is administered. If the calf suckles, the warm water is given by nipple bottle. What fluid is not consumed by suckling is administered by esophageal feeder. The warm water is necessary to complement the HYSS administration but is an adjunct in maintaining or restoring normal body temperature of the calf.

At this time, the calf may receive vitamin E and selenium at the prevention dose. If there is marked facial and lingual swelling with respiratory noise, a single 0.1 mg/kg dose of dexamethasone IV may be administered. The calf is placed in sternal recumbency and moved from side to side and encouraged to stand. Passive limb motion improves thermoregulation through muscle activity. Colostrum (3-4 L) or a colostrum replacement product (150-200 gm IgG) is administered as soon as there is a suckle response, but no later than four hours after delivery.

Intravenous Catheter Placement

The need for plasma, fluids, medications, and/or nutrition to be administered safely, effectively, repeatedly or continuously over time makes intravenous catheter placement necessary to provide optimal care to critically ill calves. Sick calves previously managed without an IV catheter need an IV catheter if they become semi-comatose, are more than 8% dehydrated (skin tent on the neck persists for more than five seconds), have refused feed for more than 24 hours, and have ileus or abdominal distension, or become septic or toxic.

The external jugular vein provides easy access and is less likely than many other peripheral veins to be in continuous contact with the environment. If left and right jugular veins cannot be used, other peripheral vein

options include the auricular, cephalic, and saphenous veins. Two catheter types are used most frequently in our hospital: 1) over-the-needle catheters (Mila International, Medical Instrumentation for Animals; www.milaint.com; BD Angiocath™ Becton Dickinson Infusion Therapy Systems, Inc., Sandy, Utah); and 2) over-the-wire catheters (Arrow International, Inc., Reading, PA). We rarely use peel-away catheters. Over-the-needle (OTN) catheters are easy to use and low-to-moderate cost. During insertion, the catheter and needle are inserted as a unit through the skin, a process that carries drag and resistance. OTN catheters are rigid to counteract the skin drag and are, therefore, considered short-term and should be replaced approximately every 72 hours. Over-the-wire (OTW) polyurethane catheters are more expensive than most OTN catheters but are used more frequently in our hospitalized neonates because the material is less injurious to the jugular vein upon insertion and, when properly managed, are considered for long term use up to three weeks. The OTW catheters have a longer length and a soft, more pliable consistency. Single- and double-lumen OTW catheters are available, making it possible to administer crystalloid fluids and antibiotics through one port while nutritional solutions that are much more prone to bacterial contamination are administered through the other port, which is never disconnected except to replace lines. Some OTW catheters are available with an antimicrobial coating.

Catheter diameter and length must suit the patient, the vessel being catheterized, and the skill of the technician. For most 77-110 lb (35-50 kg) calves, jugular vein catheters are 14- or 16-gauge. The length of OTN catheters is shorter, but we rarely use a catheter that is less than 3.25 inches in length. Because of the diameter of the jugular vein, a large-diameter catheter can be used to achieve steady flow rates. The length of the OTW catheters are usually 6 to 8 inches in length. Catheter choice is based on the condition of the patient, length of anticipated need, cost, availability, clinician/technician preference, patient housing, and restraint. Catheters must be maintained in place with little to no friction or movement with movement of the calf, IV lines or catheter use. We suture catheters in place at the catheter hub-jugular vein junction (through a catheter clip or butterfly tape) and another several inches away over the IV line. A light bandage wrap usually covers the catheter site but makes ready access for injection port use and inspection. Most IV lines extend back to the thorax, where they are held in a non-stick bandage wrap around the cranial thorax.

Once in place, patients with IV catheters are monitored closely and physical exam parameters are taken at least twice daily. Specific to the catheter, the jugular vein is examined for pain, swelling, heat, bleeding, and patency indicative of unusual inflammation, infection,

cellulitis or thrombosis. Catheters not continuously used for fluid administration are flushed with heparinized saline solution that delivers 10 units of heparin/ml (48 hr expiration). Some general catheter maintenance guidelines used at the University of WI School of Veterinary Medicine are:

- Monitor twice daily. At any sign of thrombophlebitis, catheter is removed, the tip may be submitted for aerobic and anaerobic bacterial culture, new catheter placed in opposite jugular vein
- Flush the catheter between all medications to avoid precipitation between non-compatible drugs, e.g. flunixin
- Change any IV lines containing dextrose solution every 24 hr
- Change total parenteral nutrition lines (TPN) with each new bag of fluid
- Change injection caps (PRNs) daily
- Maintain catheter bandage wraps
- Monitor IV fluid patients hourly
- Check expiration dates of catheters before use

Delivering Critical Care

The important focal points of critical care to calves are respiratory support, effective circulation, and nutrition. Treatment failures can usually be attributed to hypothermia, hypoglycemia, acidosis (respiratory and/or metabolic), sepsis, dehydration, and/or starvation. To determine the specific needs and deliver an effective treatment plan, the patient needs to be evaluated, assessed, and monitored at frequent intervals. External thermal support for young calves in the form of electric heating pads, circulating warm water pads, and heat lamps are not efficient and may be dangerous. Deep straw bedding and clean calf blankets are very useful for calves maintained in the farm environment. Warm milk, water, and oral electrolyte solutions are also useful.

Respiratory support can be delivered to calves by mask, intranasal catheter or endotracheal tube. Portable devices that deliver oxygen on a short-term basis are used on many farms and in hospitals, but longer term needs are more effectively accommodated in ambulatory calves by intranasal oxygen administration.² Humidified oxygen is delivered at a 5 to 6 L/min flow through a 10 F intranasal catheter that has been inserted through the nose, advanced to the level of the medial canthus, and held in place using a homemade halter device (Figure 1). Pharmacologic stimulation of respiration with doxapram is not consistently effective and may be contraindicated.⁶

Cardiopulmonary arrest in calves is frequently the result of sepsis, toxicity, or trauma at birth. Advanced pulmonary disease may be a contributing factor. While relatively rare, external compressions may be attempted

in some calves with very little guidance from the literature as to the most appropriate method. From a recent review,⁶ a technique successful in large dogs may be useful for calves. The calf is placed in right lateral recumbency on a firm surface. The person performing the compressions stands above the calf. One hand is put on top of and parallel to the opposite hand and placed over the widest part of the chest. Apply pressure with the palm of the hand and compress the chest 80 to 100 times per minute, using a 1:1 compression to relaxation ratio. We know of no medications that are effective for asystole, although epinephrine (1:1,000) is frequently given at an initial dose of 0.01 mg/kg IV) and repeated at three to five minute intervals. Atropine may be given at a dose of 0.04 mg/kg SQ or IV if there is a persistent bradycardia.

For ongoing circulatory support of critical calves, IV fluid therapy can be very useful. High-volume fluid therapy should be avoided unless there is hypovolemia. Initial circulatory support with hypertonic saline solution as described above is useful. Intermittent delivery of a 10 ml/kg IV fluid bolus is another alternative. For continuous IV fluid delivery, a balanced electrolyte crystalloid fluid like Plasmalyte or Normosol should be used with a flow rate between 40 and 80 ml/kg per 24 hours. Supplemental dextrose and potassium may be needed. Bovine plasma is administered to calves with failure of passive transfer, hypoproteinemia or sepsis. The optimal dose of 20 to 40 ml/kg provides 1 to 2 L of plasma intravenously to most calves. Commercially available

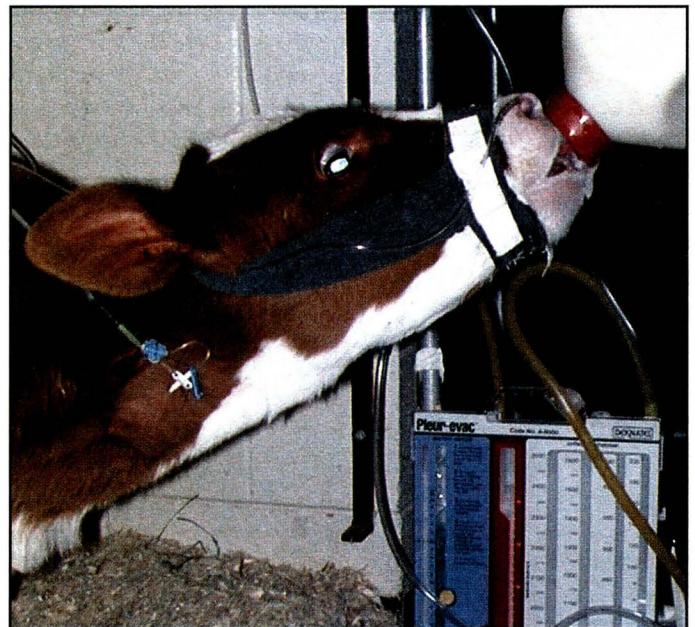


Figure 1. A calf with an intranasal catheter held in place by a homemade halter. An intravenous catheter is also shown sutured in place.

bovine plasma is a challenge to find, leaving a need for additional studies of other colloids and blood products in calves. On-site blood donors are an advantage of some hospitals and clinics, but collection of blood and separation of plasma is challenging. Close monitoring of vital signs during plasma transfusion is necessary to avoid adverse reactions.

Pharmacologic circulatory support is not well documented in calves and the protocols used are usually adapted from human and companion animal protocols. Whether interventions with epinephrine, atropine or other magnesium- or calcium-containing drugs result in improved survival is not known. Of current interest is alternate dosing of epinephrine and vasopressin or substitution of vasopressin for epinephrine. Vasopressin, a non-adrenergic endogenous pressor peptide which causes peripheral, coronary, and renal vasoconstriction, is given IV at a rate of 0.2-0.8 U/kg.⁶ Constant rate infusions (CRI) of dopamine or dobutamine can be titrated to effect in some septic calves to restore blood pressure.

Nutritional support of newborn calves is critical as the body fat reserves that can be mobilized for energy are negligible. Failure to eat for more than 12 hours can result in life-threatening hypoglycemia and protein catabolism from which calves cannot recover. If possible, sick calves should be fed milk or milk replacer. To reach targeted weight gains, a normal 100 lb (45.4 kg) Holstein calf must consume 1.8 lb (0.8 kg) of a 20:20 milk replacer powder in a 24-hour period. While it is a lofty goal to get sick calves to voluntarily consume this amount of milk replacer, more frequent small feedings and intermittent forced feeding using the esophageal feeder can be attempted. With prolonged anorexia (48 hours or more), total (TPN) or partial (PPN) nutrition should be considered, and foal protocols are frequently adapted for calves.³

Monitoring Calves that Require Critical Care

Depending on the severity of illness and the level of intervention, calves should be monitored at least four times daily. In addition to vital signs, packed cell volume (PCV), total protein concentration, and blood glucose concentrations are monitored at least twice daily. Arterial or venous blood gas concentrations are followed daily, especially in patients receiving adjunctive

respiratory support. Electrolyte concentrations—sodium, potassium, chloride, and bicarbonate—or total carbon dioxide and creatinine concentrations are monitored every other day as needed. Muscle enzyme concentrations and other serum chemistries may be monitored, depending on need. Calf-side testing of passive transfer and glucose status can add value and efficiency to critical care assessments. Venous and arterial sampling can be managed with adequate restraint and should avoid the fluid administration catheter when possible. Close monitoring facilitates the prompt changes in therapy that reduce treatment time and improve survival.

Conclusion

Calves are valuable to the future of the dairy. The ability to identify and respond to critical care needs in an efficient and effective way can be a value-added service provided by the veterinarian-veterinary technician team on the farm or within the veterinary clinic or hospital. The training of certified veterinary technicians is well suited to the implementation of critical care protocols and delivering on-farm training of specialized calf workers.

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