UNIVERSITY OF CALGARY
FACULTY OF VETERINARY MEDICINE

This review accompanies the relevant episode of the Cutting Edge veterinary podcast. In each episode of this podcast, 3rd year students in the University of Calgary's veterinary medicine program fill you in on the most up-to-date literature and evidence-based practices on topics that matter to you, the practising veterinarian.

Decision Tree for Neonatal Calf Management

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Following an assisted calving, neonatal calves may present with complications including hypoxia and acidemia as they adjust to the extrauterine environment[1,2]. There are intervention options that may be used to improve calf health and viability, and research is currently being done to advance the knowledge base on neonatal calf resuscitation. There are also common interventions that are contraindicated or are not evidence based, which may make decision making for new practitioners more difficult. While there have been several novel treatments that have recently attracted attention, not all of them have been proven clinically effective. We gathered relevant literature to create a simplified decision tree to be used following an assisted calving to mitigate complications. Included are specific milestones with normal parameters that calves should achieve and a systematic approach to interventions when these milestones are not met. This decision tree will be a useful tool for veterinary practitioners and producers to refer to while preparing for calving, as well as for training clients and staff members.

Normal Calf Milestones

There are four critical milestones that healthy calves should reach within the first few hours of birth. Calves without a heartbeat are rarely resuscitated in the field[3], therefore we will focus on resuscitation techniques for calves born with a heartbeat. The first, and arguably the most important, is achieving spontaneous respiration within the first 30 seconds of birth[3,4]. Secondly, calves should position themselves in sternal recumbency and remain in this position by 2-3 minutes after birth[5]. Thirdly, though they may not stand up immediately, calves should attempt to stand relatively quickly after being born. Previous reports in the literature state that standing should take place within approximately 15 minutes[5]. Finally, calves should nurse on their own and consume colostrum within the first four hours of life for adequate transfer of passive immunity[6,7,8].

Assisted Calving Complications

First Milestone

In contrast to the normal calf milestones described above, there are several complications that may occur after an assisted calving. Firstly, there may be problems with spontaneous respiration. There are several interventions that a veterinarian or trained producer can do to stimulate respiration, if a calf is not breathing. After any assisted calving, the calf should first be put into the calf recovery position, which is in sternal recumbency with both forelimbs and hindlimbs pointing cranially[4]. A calf should never be hung upside down, as this increases pressure on the lungs making it more difficult for it to breathe[9]. After placing the calf in the recovery position, we need to ensure that the airways are clear by swiping any fetal fluid, mucus or debris away from their mouth and nostrils[4].

At this point, we recommend palpating or auscultating for a heartbeat. As mentioned above, calves with no heartbeat are very unlikely to be viable and typically cannot be successfully resuscitated in the field. Epinephrine may be considered if there is no heartbeat[4] at a dose of 0.01 mg/kg IM. If a heartbeat is present, efforts to resuscitate the calf should be continued.

Next, rubbing the calf over the rib cage, poking the nasal septum with a piece of straw[10], or squirting cold water in their ear may help stimulate breathing[3,11]. If there is no spontaneous respiration after 1-3 minutes of being in the extrauterine environment, consider alternate methods of ventilation[4]. Manual ventilation needs to take place at this point if they are still not breathing. There are several methods for this including endotracheal intubation, a laryngeal airway mask (LMA), or the McCulloch medical respirator (MMR)[1,12]. Manual respiration should be done at a rate of 15-25 breaths per minute[4]. If none of the recommended tools are available to you, a last resort could be performing mouth to nose respiration with the other nostril being covered[1]. Doxapram may also be considered as a drug to improve respiratory function, 2 mg/kg IV[13]. This will be discussed in detail subsequently. After spontaneous breathing is successfully stimulated, move to stage 2 of the decision tree.

Second Milestone

The second milestone after a calf has been born and is breathing is maintaining sternal recumbency[5]. If the calf cannot lift its head or maintain sternal recumbency within 2-3 minutes of being born, it may be hypoxemic or acidemic. If the calf has been breathing successfully and the sternal recumbency milestone is not met, check the pulse. If bradycardic (HR < 60), consider administering low dose epinephrine (0.01 mg/kg IM)[15].

Mixed respiratory and metabolic acidemia following birth, especially a dystocia, is common and normally resolves within 24 hours[7]. However, it's important to identify acidemic calves because they are less likely to consume adequate colostrum for transfer of passive immunity. While collecting blood for a blood gas analysis is a definitive way to determine blood pH and differentiate between metabolic and respiratory acidosis, it is not often practical in a field setting. The use of a handheld lactate meter is a more accessible method of identifying acidemic calves[7]. The absence of a suckle reflex is also an indicator of acidemia. If the calf is identified as being acidemic, assist the calf with colostrum consumption. If you suspect that they are severely acidemic, based on blood gas, blood lactate, or the absence of a suckle reflex,

consider administering sodium bicarbonate or carbicarb IV[15]. The recommended dose of sodium bicarbonate to administer is determined by the calf's base excess, and by the formula: body weight x 0.5 x (-base excess) = mmol $NaHCO_3$[15]. Base excess in a calf following birth is generally between -3 and -5 mmol/L[13,15], so if it is not possible to determine the calf's base excess, this works out to 1.5 - 2.5 ml/kg of hypertonic bicarbonate (8.4%).

Third Milestone

If the calf is now breathing on its own and is maintaining sternal recumbency, the third milestone a calf should reach is attempting to stand. Ideally this occurs during the first 15 minutes, but more realistically, if the calf is not maintaining a standing position by 3-4 hours[5] then it is time to intervene. There are a couple of options for interventions, again depending on the calf. If the calf

is alert, you can give it colostrum. Check the temperature for hypothermia. If it is below 36.5°C, the calf should be warmed up with heating devices such as electric heating pads, circulating water heating pads, or infrared heaters, taking care not to burn the calves, until the rectal temperature is above 36.5°C[4].

If the calf is not alert and seems dazed, the Madigan squeeze is another option. There have been two calves described with behaviour similar to a neonatal maladjustment syndrome foal (i.e. refusal to suck, indifference to environmental stimuli, motionless standing, etc.)[16] Both calves underwent a thoracic squeeze technique, with a soft rope looped around the thorax and gentle pressure applied for 20 minutes. When the rope was removed, the calves woke up, rose, and walked towards the dam. They both followed the dam and sucked normally by the next day[16]. These were two calves, and whether or not this technique could be useful across different populations has not been studied. However, it is used in foals and has had some evidence of success in lambs[17]. Therefore, this may be an option to consider in the case of suspected "neonatal maladjustment syndrome" in a calf.

Fourth Milestone

The fourth milestone we would like calves to achieve is nursing on its own and consuming sufficient colostrum ideally within 4 hours[8]. If the calf has not nursed by this time, give it colostrum. If the calf has achieved this, continue monitoring the calf but no immediate interventions are necessary.

Pharmaceutical Options to Consider

The most important interventions have already been described. However, there are also additional interventions that you may want to consider with these assisted calves. Drugs to consider include doxapram, meloxicam, caffeine, sodium bicarbonate. Intranasal oxygen is an additional intervention that should be given consideration. Most importantly, if you can get

these calves breathing on their own, they will likely correct within 24 hours with supportive care and colostrum[6].

Doxapram is a fast acting, effective respiratory stimulant and has been shown to be effective in clinical studies[13]. However, there was a potential risk of hypoxic pulmonary and cerebral vasoconstriction as well as cerebral hypoxia due to temporary hypocapnia following administration. Doxapram is also contraindicated in premature calves. Doxapram is certainly a drug to consider if your calf is not breathing, especially if you cannot intubate[13].

Another drug to consider is meloxicam. Dairy calves have been shown to have improved vigour, suckle reflex, and milk intake when given meloxicam following birth[18] A study done here at UCVM in beef calves found that while there were no improvements in passive immunity or health, there was an increased average daily gain in these calves at 7-10 days old. There were no decreases in physiologic indicators of pain (i.e. serum cortisol and heart rate). Improvements in early growth may have important impacts on beef calf management[19]. Meloxicam should be given to calves at a dose of 0.5 mg/kg subcutaneously.[18,19]

It has been suggested that caffeine may improve neonatal calf vitality. There have been anecdotal reports that dull calves become more alert after receiving caffeine[20]. There is evidence in premature apneic human infants that caffeine improves brain, lung and heart function[21], but there

is no clinical evidence that it is efficacious in calves. If attempting this intervention, provide 100-200 mg of caffeine orally[20].

Severely acidemic calves with a blood pH of less than 7.2 should be treated by improving gas exchange or by administering $NaHCO_3$[13]. It's important to note that calves that are not breathing properly will have respiratory acidosis, which should be corrected by improving gas exchange before addressing any other acid-base imbalances. Intravenous sodium bicarbonate administration may be considered to correct metabolic acidosis. If the calf is breathing, excess CO_2 generated by the administration of $NaHCO_3$ will be exhaled[15]. Calves treated with IV sodium bicarbonate reach an appropriate blood pH faster than those left untreated[15]. See milestone two for details on sodium bicarbonate administration.

If available, providing oxygen to a neonate may be beneficial. If it is possible, measure SaO_2 to determine the need for oxygen. If obtaining blood gas measurements is not feasible, this can be accomplished using a pulse oximeter[15]. If it is determined that the calf needs oxygen, consider using an oxygen concentrator while the calf recovers. Advance a soft nasal cannula intranasally to the level of the medial canthus and administer oxygen at 2-10 L/min[4]. Administering oxygen in one nostril ensures that the calf receives an air-oxygen mixture[2]. Remember that intranasal oxygen only improves the availability of oxygen to the calf, it will not help if they are not breathing properly or are cardiovascularly compromised.

Acknowledgements

We would like to extend a sincere thank you to our UCVM faculty mentors on this project, Dr. Claire Windeyer and Dr. Jennifer Pearson.

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