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Review Article

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Managing Cold Stress in Young Dairy Calves: a Review

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Abstract

This paper addresses cold stress in young dairy calves, an underestimated phenomenon which may lead to economic losses when not properly dealt with. First, an overview is given considering the background of cold stress occurrence. Next, practical tips are described for managing cold stress and, when possible, prevent its negative effects. Distinguished are the three domains of general management, feed & feeding management and health management.

It would be best when the veterinary practitioner sits together with the farmer to design protocols such as for routine monitoring of young calves, and to define the management measures to take before and when cold stress occurs. These protocols and management measures should be tailor-made for the individual dairy farm. The coaching role of the veterinary practitioner, like in the case of applied herd health and productivity management programs, can be substantial for success.

Introduction

Contrary to heat stress in dairy cattle, literature on cold stress is sparse. Nevertheless, cold stress in young stock may be very detrimental for health and future performance. Cold stress is largely underestimated and hence may cause substantial economic loss, both at short term, including mortality, and in the long term (poor lactation performance and early culling).

Like for the implementation of veterinary herd health and production management programs on dairy farms (Brand et al., 2001; Noordhuizen, 2012), an integrated approach is best to make the farmer understand what is going on, to facilitate the actions for the farmer and to adapt protocols and management measures to the individual farm management style.

The objective of this paper is to present a practical approach to cold stress management, elaborating often simple management measures to prevent and/or control cold stress and its effects in young dairy calves.

Cold Stress occurrence: background

Calves are born with a limited reserve of body fat, usually sufficient for one day only. At an age of 6 weeks, calves have still less than 4% of body fat. Especially when diarrhea occurs, feed intake is lowered, which aggravates the situation. The ratio between the outer body surface and internal body mass is an important parameter. The smaller a calf, the more important this ratio will be.

Physiological thermogenesis is the process which is aimed at keeping a calf in body temperature homeostasis. The thermoneutral zone of a calf is the body temperature range within which a calf has

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no efforts to do for keeping its body temperature at correct level. The thermo-comfort zone is the temperature range within which a calf 'feels best' and at ease. The latter zone lies within the thermoneutral zone but is smaller in range. Table 1 presents the threshold values for cold stress in calves under 3 weeks of age and those older than 6 weeks of age (Litherland, 2013; Sockett, Behr & Earley-wine, 2014; Renelt, 2014). In comparison, the thermoneutral zone for adult cows is between -5°C to +23°C.

Age of the calf	Cold stress occurrence risk	Thermoneutral zone
< 3 weeks	< 15°C ambient	15—22°C
4 weeks		6—22°C
> 6 weeks	< 5.5°C ambient	6—22°C

Table 1: *Ambient cold stress threshold values for young dairy HF calves and, in comparison, their respective thermo-neutral zone.*

A mild cold stress occurs when the dairy calf's core body temperature falls below 38°C; a severe cold stress occurs when the calf's core temperature falls below 35°C. In this case, essential organs may get (too) cold to function normally (Renelt, 2014). Below 30°C core body temperature, a calf may die from the cold, especially when diarrhea is present.

Cold stress in young calves can be observed in either one of two phenomena: (1) Exposure cold stress, and (2) Immersion cold stress (Renelt, 2014).

Exposure cold stress is a gradual occurrence of hypothermia causing a steady body heat loss in a cold environment, often with strong wind, by respiration, evaporation and a relative lack of haircoat, body mass and/or weather protection.

Immersion cold stress is a rapid loss of body heat caused by a wet, saturated haircoat in a cold environment. It may often occur after birth when the calf is wet with urine and uterine liquids. Dystocia is a primary cause for cold stress in forenamed conditions. Dystocia leads to a lack of oxygen in the calf and indirectly to a compromised immune system. Dystocia calves will develop a pneumonia or diarrhea more easily. Other, causal factors are a birth in heavy rain fall with cold winds blowing or in the snow outside, or on very wet cold grounds, or when falling in a cold water-stream.

Early clinical signs of cold stress may be frostbite of ear-tips, tail and rear feet; note that front feet are commonly under the body (Leach, 2016). Calves are reluctant to stand up. Later-on the affected body parts become hard and leathery. Frostbite leads to increased disease susceptibility due to tissue cell damage and lower blood circulation in extremities. Cold stressed and older sick calves are most susceptible (Leach, 2016).

A calf has several biological mechanisms to keep warm at a homeostatic level. Among these mechanisms are shivering which generates heat, the level of glycogen in the muscles, a clean and dry haircoat providing an insolation against body heat loss. The farmer too has options to avoid too much heat loss in a calf. An example is feeding management addressing feed volume, daily feeding frequency, and adding extra fat to the meal. Farm management has a crucial role in keeping calf's body temperature at optimal level: adequate colostrum management, proper navel dipping, providing dry clean housing with a thick straw layer, managing barn temperature, proper sanitation of calf hutches and barns, providing heat lamps or calf jackets (Litherland, 2013). These elements are addressed in more detail below.

Practical tips for optimizing calf's body temperature in cold conditions

When the weather conditions are such that there might be a risk of cold stress (see Table 1), the farmer should prepare himself for counteracting potential negative effects. A thermometer is an elementary tool for knowing what is going on. If body temperature is below 38°C, or worse below 35°C, all necessary actions have to be taken. The crucial point is to bring the calf's body temperature as soon as possible back to at least 38°C.

***General management measures**

The primary management actions are listed in Table 2 (after Renelt, 2014; Leach, 2019). The calf caretaker should be vigilant too to prevent him from cold stress problems.

Photo 1: The insulating calf jacket in place.

Tip: put on the calf jacket when the outside ground has frozen (Morrison, 2018)

Prepare dry clean towels or reusable blankets to rub the calf thoroughly.	If available, put a calf jacket on the calf to warm the calf up. See Photo 1.
Provide a thick dry straw layer (at least 40 cm) in the hutch that covers the calf's legs and claws at all times.	Sometimes floor heating has been installed; used it properly. An alternative is posing a heating lamp above the calf.
A severely cold wet calf could be put first in a warm water bath and rub it thoroughly to dry afterwards.	Give the calf its first 2 L colostrum (of checked, optimal quality) as soon as possible.
Check rectal temperature daily.	A calf barn should be well ventilated and not closed. Positive pressure ventilation is optimal but should be tailor-made.
Barn temperature should be above 15°C during the first 48 hrs.	Apply adequate sanitation measures for calves and equipment.
Design a sick-calf treatment protocol comprising calf ID, signs, drugs, dosage	Store and identify drugs properly. Note the date of first use on the bottle.

Table 2: *Primary management issues to take care of in cold stressed calves.*

***Measures related to feeding**

Some elementary feeding and feeding management issues are summarized in Table 3 (adapted after Sockett & Behr, 2014; Litherland, 2013; Renelt, 2014; Sockett, Behr & Earleywine, 2014).

Note that a Negative Energy Balance which lasts for 3 to 5 days may lead to death of the calf (Sockett & Behr, 2014).

3 L milk or milk replacer twice daily provide under normal conditions sufficient growth par day. Provide warm water at 38-40°C within 30 min after a milk or milk replacer meal. All liquids should be fed at 38-40°C	But twice a day feeding should be increased to three times daily feeding to maintain energy and protein supply at the level needed by the calf. Otherwise, weight loss occurs. Increase volume fed by 30% (3 L per meal). Increase hence total solids fed from 12% to 15%.
Plan to feed calves before milking the cows. Place water of 37-38°C several times per day for the first 30 days.	Three feedings a day will provide 0.75 to 1 kg of milk replacer powder with 20% fat. Check starter intake weekly; a too low intake at 10-14 days points to a problem.
Provide proper high protein (18-22%) calf starter from Day 2 or 3 onward in small volumes (handful) for the first week of life. Fat addition only for the first 2 weeks	The needs of a sick calf (pneumonia; diarrhea) in energy and protein increase too. Hence, meal contents or number of meals per day have to be increased.
Slowly wean off of the fat. Weaning a calf during extreme cold weather causes an additional stress in calves. Delay weaning until ambient temperatures become less extreme.	Check daily growth rate until weaning, ensuring that the rate remains at 500 to 650 gr per day. Note that Jerseys have a 15% higher energy demand than HF calves.
Be consistent in feeding hours: always at the same times of day.	One may consider feeding per meal 2 de-frozen cubes of colostrum from Rota/Corona-vaccinated cows to provide additional IgG
Have electrolytes available for dehydration cases in sick calves	If indicated, apply tube-feeding with the milk or the electrolytes solution at 38°C.

Table 3: *Elementary feeding management issues for cold stressed young calves.*

***Health management**

With regard to health management, a daily routine monitoring of the individual calves is essential. Design Routine Monitoring Sheets (Noordhuizen, 2012) with a date for facilitating this action. Table 3 presents an example of headings on this routine monitoring sheet and examples of scoring results (score 1 is okay; score 2 is a slight deviation; score 3 means bad, action required).

The haircoat of a healthy calf is shiny. Its eyes are attentive and bright. The ears are not dropping. Normal feces are brown and creamy. Rumen fill score is 2.5-3.0 pointing to a well-filled, active rumen. Feces consistency and feces fiber content scores indicate an appropriate digestion or not. Bedding conditions should be dry-deep-clean (score 1); each deviation causes a score 2 or 3. Moreover, one can score hygiene of the hutch and barn, as well as ventilation of the barn (no moisture; no ammonia; fresh = score 1).

Cold stressed calves, treated as good as possible, following the forenamed general rules, still impose a strict follow-up of the calves when they grow older, not in the least because they are at risk for health disorders.

FARM 86 DATE: January 24

Calf ID	General appearance	Haircoat	Eyes/Ears	Feces	BCS	RF	FC/ FF	Bedding	Rect. Temp
223	1	1	1/1	1	1	2	1/2	1	38.0
248	2	2	1/1	1	2	1	2/2	1	38.2
251	1	2	1/1	1	1	1	1/1	2	38.2

Table 4: *An example of a routine monitoring sheet for young calves (headings only). ID= identification; BCS= body condition score; RF= rumen fill score; FC & FF= feces consistency & feces fiber content; Rect. Temp. = rectal Temperature in °C.*

Concluding Discussion

This paper addresses young dairy calves without detailing per age group, such as younger than 3 weeks and older than 4 or 6 weeks. The first reason is that this paper comprises a more general approach of young calves up to 6 weeks. The second reason is that practical tips are given, which should always be adapted to the individual farm situation. The discussion between veterinary practitioner and dairy farmer should result in the most appropriate protocols and measures to be taken. As such this forms part of a holistic veterinary herd health & productivity management program for dairy farms, irrespective of the size of the herd (Brand et al., 2001; Noordhuizen, 2012).

Pre-weaned calves show an average mortality rate of around 7 to10% (Renelt, 2014). This is mostly due to respiratory problems and diarrhea. The latter two are associated with dystocia and hypothermia at a large proportion. The hypothermia in young calves may decrease immune-responsiveness and, hence, contribute to a higher disease incidence afterwards. Daily growth rate is always affected.

These phenomena should be a main reason to pay a lot of attention to preventing hypothermia and control the negative effects as much as possible, especially in the youngest calves (0 to 3 weeks of age) because they are at highest risk. And even when a cold stressed calf survives, its performance level in first lactation might be heavily impaired. Therefore, these calves should be followed up till their first calving and in their first lactation.

Farm management quality level is the key factor of success. It should address the forenamed three main domains: (1) general farm management, (2) feed and feeding management, and (3) health management.

The veterinary practitioner, with or without a nutritionist, can assist the farmer in designing the most adequate protocols and management measures to keep young dairy calves as healthy and comfortably as possible. Coaching of the farmer by the veterinary practitioner is another key element for success.

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