Managing Transition Cow Issues

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Abstract

A smooth transition from the late dry period through early lactation has profound impacts on the success of both the lactation and conception.   Most problems that herds experience during transition manifest as metabolic disease issues, or stem from them. High incidence rates of retained placenta, metritis, ketosis and displaced abomasums can be obvious reasons for poor herd performance. However, often metabolic problems are still the root of suboptimal performance but go unnoticed on many dairies. Monitoring transition cow health through routine ketone testing or with precalving serum tests can be a valuable tool for tracking herd metabolic status and helping to uncover reasons for transition cow problems.   Metabolic problems on most herds usually have multiple component causes that will frequently relate to cow, feed, and environment problems. These causes may include many factors such as pen density or feed access issues, stressful grouping strategies, frequent group changes, feed issues or body condition problems. Effective monitoring programs can not only help identify problems but can be used to track the success of management changes.

Introduction

Unraveling the cause of transition cow problems is a complex task. The "cause" will always be multifactorial, meaning that there will be multiple components that have ultimately contributed to the eventual problem. Since this is the case, often investigations will stop once one issue has been identified. A solution or remedy directed at this one particular issue may fail to alleviate the big problem. The investigation will then continue until the next issue is identified. This process is frustrating and lacks a systematic approach. Recognizing the multifactorial nature of disease and using a systematic approach to problem solving can help with making a more efficient diagnosis and often remedy the transition cow problem much faster.

Most problems that herds experience during transition manifest as metabolic disease issues. High incidence rates of retained placenta, metritis, ketosis and displaced abomasums can be obvious reasons for poor herd performance. However, suboptimal performance may be caused by subclinical metabolic disease and go unnoticed on many dairies. Monitoring transition cow health through routine ketone testing or with precalving serum tests can be a valuable tool for tracking herd metabolic status and helping to uncover reasons for transition cow problems.   Metabolic problems on most herds usually have multiple component causes. These causes may include many factors such as pen density or feed access issues, stressful grouping strategies,   frequent group changes, feed issues or body condition problems. Effective monitoring programs can not only help identify problems but can be used to track the success of management changes.

Circulating concentrations of non-esterified fatty acid (NEFA) and β-hydroxybutyrate (BHBA) measure the success of adaptation to negative energy balance. NEFA reflects the magnitude of mobilization of fat from storage. BHBA indicates the completeness of oxidization ("burning") of fat in the liver. Ketone bodies (BHBA, acetone and acetoacetate) are intermediate metabolites of oxidation of fatty acids; as the supply of NEFA to the liver exceeds the ability of liver to completely oxidize the fatty acids to supply energy, the amount of ketone body production increases. Ketone bodies can be used by muscle as an alternative fuel source to glucose, sparing glucose for milk production (Herdt, 2000a). However, ketone production does not result in as much net energy release as does complete oxidation of fatty acids. Additionally, increasing concentrations of ketones are thought to suppress feed intake.

Glucose is the primary metabolic fuel, and is absolutely required for vital organ function, fetal growth, and milk production. In dairy cows, the massive energy demand to support milk production is partly met through gluconeogenesis. Glucose concentrations are under tight homeostatic control. Therefore, although glucose has a central role in metabolism, it is a poor analyte for monitoring or investigating herd problems (Herdt, 2000b). Aspartate aminotransferase is an enzyme that becomes elevated with cell damage and may be elevated in cows with fatty liver disease. Although there have been associations between AST and subsequent occurrence of displaced abomasums (Geishauser et al, 1997), the test lacks both sensitivity and specificity. For energy balance NEFA and BHBA are the best two measures.

Calcium demand is tremendous immediately postpartum and monitoring serum calcium in cows less than a week following calving may have some utility but before or beyond this time period, it makes no sense to measure calcium. Recently, low serum calcium concentrations (subclinical hypocalcemia) have been linked with increased risk of early lactation culling (Duffield et al, 2005).

Haptoglobin is an acute phase protein that becomes elevated under situations of inflammation. However, this inflammation indicator is non-specific and could reflect for example dystocia, mastitis, metritis or displaced abomasum. However, despite its non-specific nature haptoglobin may have utility for monitoring transition cows. **Currently the strongest data exists for the use of NEFA and BHBA testing in transition dairy cows.**

Impact of Transition Cow Metabolic Parameters on Performance

Key associations of NEFA and BHBA with health and performance in transition dairy cows are:

- High NEFA in the 2 weeks before calving is associated with
  - 2 to 4 times increased risk of LDA
    (Cameron et al, 1998; LeBlanc et al, 2005; Opsina et al, 2010)
  - 1.8 times increased risk of retained placenta (RP) (LeBlanc et al 2004)
  - 2 times increased of culling before 60 days in milk (DIM) and 1.5 times increased risk of culling over the whole lactation (Duffield et al, 2005)
  - Reduced milk yield (Carson, 2008; Opsina et al, 2010)

- Subclinical ketosis (BHBA > 1200 – 1400 μmol/L) in early lactation is associated with
  - 3 to 8 times increased risk of LDA (Duffield, 1997; Geishauser et al, 2000b; LeBlanc et al 2005)

- Decreased probability of pregnancy at first AI (Walsh et al, 2008)
- Decreased milk production (Duffield, 2009)
- Increased duration and severity of mastitis (Suriyasathaporn, 2000)

Key Monitoring Parameters for Transition Cows

NEFA

This test should only be used precalving on samples obtained within 1 week of parturition. The data for NEFA is frequently right skewed and thus averages can be very misleading. One suggested threshold is 0.5 units/L. Cows within 1 week of calving with serum NEFA above this threshold were at a 3.5 times greater risk of subsequently developing a displaced abomasums (Leblanc et al, 2005). Whole herd interpretation is best made by calculating a proportion of cows above a threshold value, however, there is limited data on an appropriate goal for this parameter. In a muti-herd 1060 cow study near Guelph, 30% of cows were above 0.5 U/L during the last week prior to calving (Leblanc et al, 2005).

One study evaluated 136 transition cows and 24 had BHBA concentrations ≥ 1400 μmol/L of serum in the first week post-calving (17.6%). There was a significant association between NEFA concentration in the week prior to calving and BHBA concentration in the first week post-calving. A nearly 5-fold increased risk of SCK was noted when the NEFA concentrations in the week before calving were greater than 0.7 mmol/L (OR=4.8, P=0.04) (Osborne, 2003).

BHBA

In contrast to NEFA, serum BHBA should only be used postcalving. The first two weeks are the primary risk period for subclinical ketosis, defined by a serum concentration of 1400 umol/L BHBA or greater (Duffield, 2009). A reasonable goal is to have less than 2 cows per 10 with BHBA above 1400 umol/L in the first 2 weeks post-calving.

Sample Handling

Both NEFA and BHBA can be measured with either plasma or serum. Both analytes are subject to interference with hemoglobin in the sample, thus, hemolysis will artificially elevate measurements and should be avoided. Both NEFA and BHBA are subject to changes relative to time of feeding. Samples meant to compare performance on the same farm should be obtained at approximately the same time of day. The most severe swing in values in our experience appears to be with NEFA with highest values obtained just before first feeding. Therefore. it is best to sample herds at some point after the first feeding of the day. NEFA concentrations could be slightly falsely elevated if serum were not separated within 12-24 h of blood collection, or if samples were not kept chilled (Stokol and Nydam, 2004). Serum can be kept frozen for at least 1 month without affecting NEFA results. Samples should be collected from the tail vein (not the milk vein) and ideally chilled, separated within a few hours, and then frozen or shipped chilled for receipt at the laboratory within 1 to 2 days. However, delay of up to 24 hours for separation, and kept at room temperature for 1 day or refrigerated for < 3 days does not substantially affect results (Stokol and Nydam, 2004).

Cowside Tests

Milk Ketone Tests

Most milk ketone tests measure acetone and acetoacetate through a reaction with nitroprusside which causes a colour change from white to pink or purple. These tests in general are poorly sensitive in milk (<40%) but highly specific (>90%) (Duffield, 1997; Geishauser et al, 1998). One exception is a milk ketone test that measures BHBA. It is marketed in Europe as "Ketolac BHB", in Japan as "Sanketopaper", and in Canada as "Keto-Test". This test has a much higher sensitivity in milk (>70%) and reasonably good specificity (>70%, up to 90%) (Oetzel, 2004). This is a semi-quantitative test that allows choosing a lower threshold for screening to increase sensitivity, and a higher threshold for diagnosis to increase specificity.

Urine Ketone Tests

The urine ketone tablet tests are based on the same nitroprusside reaction as the milk powder ketone tests. These tablet tests are highly sensitive (approaching 100%) but are poorly specific. Thus, they are great tests for ruling out subclinical ketosis with a negative test result. However, their use overestimates a subclinical ketosis problem because of a high probability of false positive reactions (see table 1). The use of Ketostix in urine allowing for only a 5 to 10 second interpretation window is highly accurate with performance as good or better than the Keto-Test in milk (Carrier et al, 2005).

Blood Ketone Tests

The Precision Xtra glucometer has been tested several times for accuracy for measurement of blood BHBA. It is highly accurate compared to laboratory values for detecting subclinical ketosis. This test is the best performing cowside test available.

Selection and Interpretation of Cowside Tests

There are two possible actions resulting from screening a group of fresh cows with a ketone test. One action might be to treat all positive animals with the goal to prevent subsequent development of clinical disease. In this case, a high predictive value of a positive test is desired so that normal animals are not unnecessarily treated. The second action might be to compare the percent of positive reactors to a goal for determining the effectiveness of either the transition ration or some prophylactic measure in reducing the incidence of subclinical ketosis. In this situation, the apparent prevalence is the parameter that actually would be used. The use of the urine Acetest tablet would substantially overestimate the prevalence of subclinical ketosis, while the Ketocheck™ test would grossly underestimate the prevalence. Despite a consideration of the inherent sensitivity and specificity of these two tests, their utility for group level decision making is questionable. However, both the Keto-Test and the Ketostix are useful tests for group level monitoring and for individual animal identification, while the Precision Xtra would be considered the best performing test of the three. The decision on which of these tests to select should be based on the convenience of taking either milk, urine, or blood, and also the cost of the test itself.

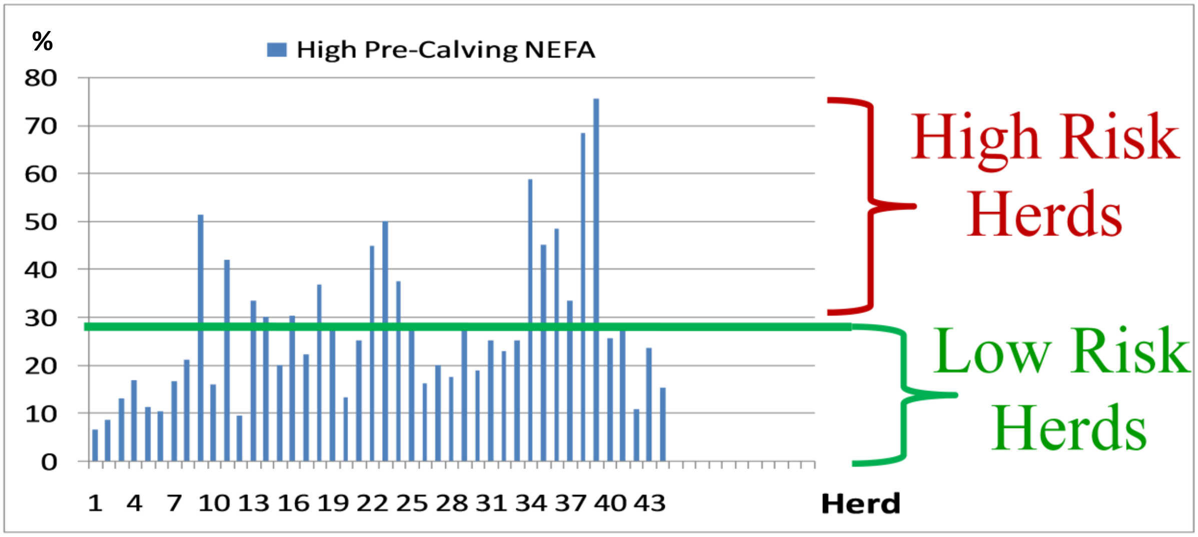
Herd Level Goals

Each herd that monitors these parameters (ketones or NEFA) should set their own goals with their advisors. A prevalence of 10% high ketones might be a problem for some herds, while on other herds this could be considered excellent performance, depending on the herd history. However, as a starting point Table 1 illustrates some suggested goals based on median values of herd performance from a multi-region North American transition cow study. Figure 1 illustrates the range in herd performance for high precalving (- 1 week from calving) NEFA values (≥ 0.5 mmol/L).

Figure 1. Suggested herd goals based on Median herd prevalence of high NEFA or ketones in a Multi-Region North American transition cow study.

Parameter	**Time Relative to Calving**	**Cutpoint**	**Median Herd Prevalence**	**HERD GOAL**
NEFA	- 1 Week Pre	0.5 mmol/L	25%	< 3/12
	+1 Week Post	1.0 mmol/L	20%	< 2/12
BHBA	+1 Week Post	1400 umol/L	15%	< 2/12

Figure 1. Prevalence of high precalving NEFA (≥ 0.5 mmol/L) across 44 herds in a multi-region North American transition cow study.



Other Tests

Herd Disease Records

Herd records are important tools for monitoring the incidence of periparturient disease. However, it is highly critical that standardized disease definitions are in place to allow comparison from year to year and from farm to farm. Producers should set goals for the minimizing the incidence of metabolic disease. Herd consultants should periodically review herd performance relative to these goals. In addition, intervention levels should also be considered. Several diseases are associated with increasing age and this must be taken into account when assessing herd performance. For example, in monitoring and comparing herd incidence of milk fever and clinical ketosis, it is important to stratify this parameter by parity. A high proportion of first lactation animals will likely give a herd a much lower incidence of milk fever and clinical ketosis, since risk increases with age.

Dry Matter Intake

Clearly cows that are mobilizing excess NEFA precalving will have suboptimal dry matter intake. Serum BHBA concentration in the first week post-calving was significantly associated with the average DMI in the week prior to calving (Osborne, 2003). There was a significant increase in the risk of subclinical ketosis (BHBA ≥ 1400 μmol/L of blood serum) if the DMI was below 12 kg/d (*OR*=5.7, *P*=0.05) in the three weeks prior to calving. If the DMI in the week prior to calving was below 11 kg/d, there was a greater risk of an animal developing subclinical ketosis in the first or second week post-calving (*OR*=2.9, *P*=0.05) (Osborne, 2003). Thus, measuring and monitoring the dry matter intake in the close-up group every week has utility. However, beware of group demographics relative to time of expected calving and parity, which can influence these parameters dramatically. Fresh cow intakes may be less useful because we are primarily interested in the intakes of cows within the first three weeks postcalving. Larger farms are more likely to have more useful opportunities for measuring dry matter intake because of the ability to group cows into parity and smaller days in milk windows.

DHI Test Day Data

Since milk fat and milk protein percentages are altered in sublinical ketosis, these parameters have been investigated for their utility in defining subclinical ketosis. Among all protein and fat parameters, a protein to fat ratio of ≤ 0.75 was the best test for diagnosing subclinical ketosis, at the cow level, in a Canadian study (Duffield et al, 1997). However, the protein to fat ratio was not a good test overall, having a sensitivity of 58% and a specificity of 69%. A big problem with both this and protein to fat ratio is the frequency of sampling. Subclinical ketosis is prevalent in the first few weeks postpartum. However, DHI testing frequency is typically every 30 to 40 days. Thus the intereval of sampling is too infrequent to hold great utility. However, the incorporation of milk ketone testing into in-line sampling methodology that could be done daily, holds tremendous promise.

Identifying High Risk Herds

Herd incidence of certain diseases may be useful to decide whether a herd has a problem with subclinical ketosis. Using data from a 25 herd study conducted in Guelph in 1995/1996, the median cumulative herd incidence of subclinical ketosis was 41% in the first two months postcalving, which crudely broke down into a threshold of 20% in week 1 and week 2 postcalving. Summary data for each herd from each cows first DHI test postcalving was used to assess the protein to fat ratio as a test at the herd level for classifying a herd as a high or low incidence herd for subclinical ketosis. If more than 40% of cows in the herd at 1st DHI test had a protein to fat ratio of less than or equal to 0.75, those herds were likely to be problem herds. This test had a sensitivity of 69%, and a specificity of 83%. Although more work needs to be done on herd level indicators of subclinical ketosis, herd level protein to fat ratios appear to be better indicators of herd level issues than individual cow protein to fat ratios are of identifying cows with subclinical ketosis problems.

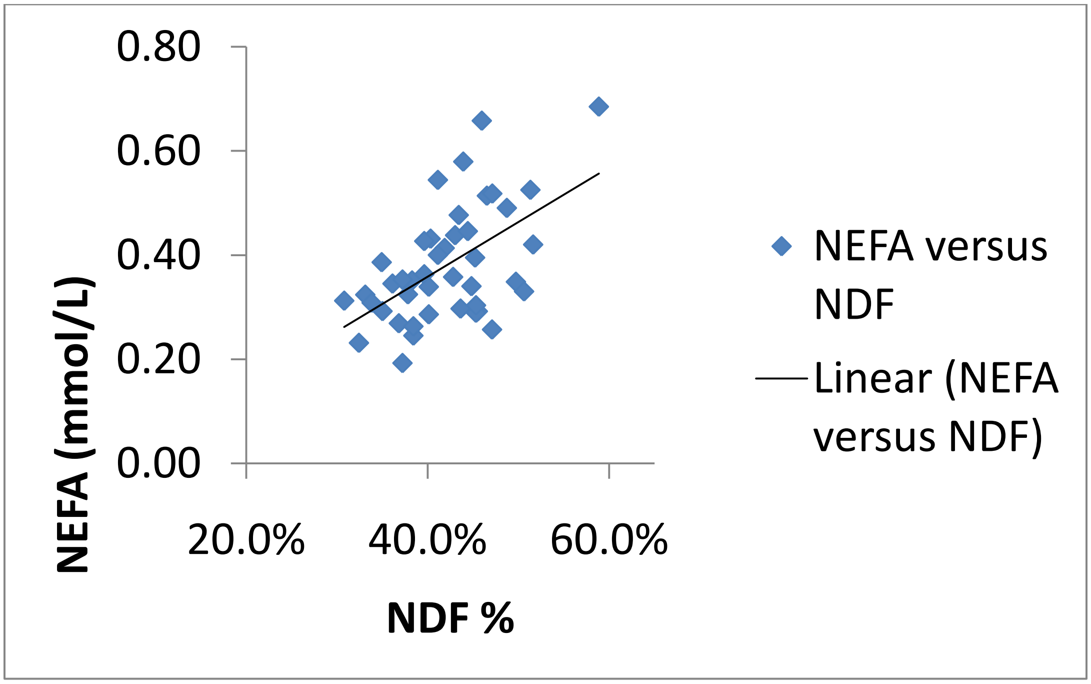
Additional analysis indicates that the herd incidence of displaced abomasum is positively associated with the probability of a herd having a high incidence (>20% in the first 2 weeks of lactation) of subclinical ketosis. In addition, if herds had greater than 10% of transition cows with a BCS ≥ 4.0 at 3 wks precalving, that herd was extremely likely to have a problem with subclinical ketosis.

Key Strategies for Prevention

Management Guidelines

Since metabolic disease problems occur in early lactation, recommendations for prevention have focused on the nutritional management of the dry and transition cow. The goals of the transition diet (specifically designed to prevent energy-related metabolic disease) are to maximize dry matter intake and to provide adequate energy density (Oetzel, 1998). Avoidance of ketogenic feedstuffs and the reduction of overconditioning cows in late lactation and the early dry period have also been suggested as aids in prophylaxis. Maximizing dry matter intake and maintenance of a consistent intake through the last three weeks prior to calving is likely the hallmark of a successful transition cow program. High fibre diets have been effective in reducing excess energy in dry diets and for maintaining rumen fill. However, NDF still limits intake; so excessively high NDF diets can reduce or limit dry matter intake. Figure 2 displays the relationship between diet NDF% in the close-up diet and herd mean precalving NEFA values (-1 week from calving) that was observed in a multi-region North American transition cow study. The relationship had an R^2 value of 0.30.

Figure 2. Relationship between NDF% in the Close-up diet and Herd mean precalving NEFA (taken 1 week precalving) for 44 herds in a multi-region North American transition cow study.



Osborne (2003) indicated that a dry matter intake (DMI) of less than 12 kg per cow per day in the last 3 weeks prior to calving substantially increased the subsequent risk of subclinical ketosis postcalving (Odds Ratio 5.7, $p < 0.05$). Achieving group DMI targets above an average of 12 kg per cow per day should be a goal for the close-up group. More important than ration formulation and ration ingredients, close attention should be paid to cow comfort and environmental issues. These factors include but are not limited to adequate pen space or stall space per cow, adequate feed bunk space, sufficient and comfortable bedding, adequate water supply and minimization of heat stress. The frequency of group changes and additions to groups around transition is a huge stressor that should be limited as much as possible. Recent research has identified several social stressors as being associated with suboptimal herd performance. These include mixing of primiparous and multiparous cows precalving, and the use of individual calving pens.

Role of Feed Additives

In addition to good nutrition, certain feed additives have been found beneficial in improving transition cow health. Propylene glycol has been used successfully for the prevention of subclinical ketosis (Emery et al, 1964; Sauer et al, 1973). Several studies have been conducted with varying doses and durations of treatment. Generally, propylene glycol is more effective when drenched because the bolus effect provides a stronger insulin response. A dose in the range of 300 to 500 ml (or 10 to 16 oz) is sufficient when started on the day of calving and administered for 3 days.

A series of meta-analysis of monensin studies in lactating dairy cattle has demonstrated that monensin through the transition period reduces BHBA, NEFA, acetoacetate; and increases glucose. These improvements in metabolic parameters result in a reduced risk of displaced abomasum, clinical ketosis, and mastitis. In addition, cows administered monensin through transition produce significantly more milk.

Rumen protected choline has been shown to influence liver glycogen and triglyceride (Pipenbrink and Overton, 2003), but not in all studies (Zahra, 2004). A topdress of 56 g per day of rumen protected choline during the transition period did not affect BHBA, NEFA, liver glycogen or liver triglyceride. However, milk production was significantly increased in choline treated cows and this effect was more pronounced in cows that were over-conditioned.

Several studies have demonstrated an improvement in dry matter intake through transition with the feeding of yeast products. However, impacts on metabolic parameters and clinical health outcomes have not been investigated to date.

Conclusions

Excessively high circulating NEFA and BHBA in transition dairy cattle are associated with increased risk of clinical diseases, lost milk production, reduced reproductive performance and increased culling risk. Estimates indicate that subclinical ketosis costs at least $78 US (Geishauser et al, 2001). This is likely a gross underestimate, since the estimate did not include impacts on culling or potential impacts on immune function. Based on return over feed cost estimates in dairy herds in Ontario, subclinical ketosis was estimated to cost $547 CDN per cow per lactation (McLaren et al, 2006). However, regardless of the accuracy of these estimates, when metabolic disease is considered at the herd level, it is considerably more costly than most clinical diseases, since subclinical disease is far more frequent. Cow-level risk factors are parity, body condition score and season of calving. Herd variation for this disease problem is wide and herd level risk factors are poorly described. However, herd level risk factors most likely involve combinations of management, feed quality and nutritional programs, cow comfort, environment, and other variables that influence dry matter intake. Routine monitoring programs for subclinical ketosis is beneficial on many dairies.