Update on Management of Transition Cows

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■ Take Home Messages

- Transition cow problems are always caused by a complex of multiple factors, including cow, environment, and feed factors.
- Routine monitoring programs for ketosis and other health parameters are key cornerstones to prevention of metabolic disease.
- Precalving assessment of non-esterified fatty acid concentrations and postcalving ketone monitoring provide an important window into transition cow health for individual cows and for the herd.
- Maximizing dry matter intake is the ultimate goal for a smooth transition.
- Additional feed additives and supplements for improvement of transition cow health should have sound science behind them to support their use on farm. Examples include oral propylene glycol and monensin sodium.

■ Introduction

There seem to be multiple recommendations for best management of transition cows. The reality is that some strategies work on some farms but not others. Rather than making broad sweeping recommendations, a guideline for transition cow investigations is perhaps more revealing. 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. Because most transition cow problems are multifactorial, the challenge is to identify and address the most critical factors contributing to the problem. Finally,

monitoring outcome success is an important and often overlooked part of the herd investigation and is the starting point for sound transition cow management. Perhaps a different way to look at transition cow management is to think about it in the context of trying to solve a transition cow herd problem.

■ So I think I have a Transition Cow Problem, What Should I Do?

What?

The first step is to define the problem and the second step is to determine if it is actually a problem. Advisors should calculate incidence of the problem using the appropriate denominator (correct population at risk) and compare this number to the target, goal, or industry standard. In addition, the problem timeline needs to be addressed. Is it a new problem or an old problem? Establish the timeline by tracking the disease incidence over time. For example, the problem is new this year, new this month, new this week, etc. Note, good records make this process much easier. This is a plug for producers to record transition cow disease! For example: A producer complains of fresh cow problems in the last month. A fresh cow problem could be anything (hypocalcemia, subclinical ketosis/fatty liver, metritis, mastitis, etc). Is the problem related to a specific disease or disease syndrome? Is it happening right at calving, within the first two weeks, or later? Is the problem either restricted to or absent from a parity group? We don't expect to see milk fever problems in first parity heifers for example.

Next Is To Identify The Following:

- Who has the problem, i.e., what are the demographics: parity, birth or calving cohort, purchased or home, etc.

- Where is the problem occurring: specific location of occurrences (calving pen, transition cow barn, fresh cow pen, etc.)

- When is the problem happening: calendar time (dates) and animal time (DIM – before or after calving)

- Why - the most difficult to understand: what has changed? Asking what has changed is usually not very fruitful; however, asking specific questions about what might have changed can be useful. Have you switched to a new bunker silo? Has the labour situation recently changed? Have you had an increase in the number of cows calving?, etc.

Look at the Big Picture

The next step I take is to try to step back and look at the overall dairy operation. We call this the *general inspection*. The general inspection consists of understanding the cow perspective on the farm. Walk through the cows from two perspectives:

‣ A day in the life of a cow (understand the farm routines)

‣ A year in the life of a cow (understand management flow from dry to calving to lactation)

In this step look for anything that is obviously wrong such as:

‣ Empty bunks

‣ Overcrowding

‣ Low or high BCS

‣ Cow comfort issues

‣ Fine rations or sorting

Detailed Herd Assessment

The next step involves a more in-depth investigation and may involve revisiting areas found to be abnormal in the general inspection. This is a systematic approach to walking through the farm that addresses issues relative to solving the problem. This would usually include:

‣ Cows: evaluation of BCS, grouping, frequency of group changes, etc.

‣ Feeds and feeding: assessment of quality, particle size, diet changes, etc.

‣ Bunk management: gathering information on frequency of feeding, push-ups, etc.

‣ Headlocks and stalls: assessment of overcrowding

‣ Environment: ventilation, stall design, bedding, floors, water

‣ Management routines and prevention/treatment measures

Clinical Tests

This is the final stage of the problem solving process that is used to help confirm or refute diagnostic hypotheses. Tests might include the following: post mortems, serum or blood parameters, forage and volatile fatty acid (VFA) analysis, rumen pH, urine pH, etc., depending on the transition cow problem being investigated.

Concept of the Tipping Point

It is important to understand that all disease syndromes have complex causes and therefore are multifactorial in nature. In working through any investigation, there will most likely be several factors that have been identified as problems and many of those will have existed for some time. This leads to the question, why now? Often, it is the combination of these factors that is important, with the last change tipping the problem over into an obvious and large clinical issue. The challenge is to identify the key factors that need to be addressed to tip the scale back toward health.

■ Key Strategies for Prevention of Metabolic Disease in the Transition Dairy Cow

Monitoring

Most periparturient abnormalities have some metabolic element as a component of the cause of clinical disease. Negative energy balance, fat mobilization and subsequent elevations in ketone body concentrations play a contributing role in the expression fatty liver syndrome, clinical ketosis, and abomasal displacement. A negative energy balance during transition may also increase the risk of retained placenta, metritis, and mastitis through impaired immune function. In addition to energy balance, nitrogen balance and calcium homeostasis are disrupted through parturition. Therefore, several biochemical parameters may be useful for monitoring cows in the transition period.

There can be two main objectives for conducting serum metabolite testing in periparturient cows. Although these objectives may overlap, it is worth stating them for clarity.

‣ Cow-level interpretation: there is a problem with this cow and treatment and/or further examination may be warranted.

‣ Herd-level interpretation: there is a potential problem with the current herd management that needs to be investigated.

Cow and herd level interpretation can be conducted with the same samples but they differ in that we are differentiating between an individual and group problem. In my opinion the group interpretation is the strongest reason for conducting the tests regardless of whether it is an ongoing monitoring program or a herd-problem investigation.

Serum Metabolites to Consider

Circulating concentrations of non-esterified fatty acid (NEFA) and β-hydroxybutyrate (BHBA) measure the success of adaptation to negative energy balance. The NEFA concentration reflects the magnitude of mobilization of fat from storage, whereas the BHBA concentration 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.

Aspartate aminotransferase (AST) 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 abomasum (Geishauser et al, 1997), the test lacks both sensitivity and specificity. For energy balance, NEFA and BHBA are the best two measures.

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 synthesis in the body). 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). However, recently we have discovered a potential role for glucose measurement in assessing treatment success. Ketotic cows with low serum glucose responded to parenteral supplementation with vitamin B12 in addition to oral propylene glycol but ketotic cows with normal serum glucose did not benefit from the B12.

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. Low serum calcium concentrations (subclinical hypocalcemia) have been linked with increased risk of early lactation culling (Duffield et al., 2005; Roberts et al., 2012) and reduced milk production (Chapinal et al., 2012). Effective monitoring of both NEFA and calcium is currently not available because of the absence of cow-side tests for either analyte.

Haptoglobin is an acute phase protein that becomes elevated under situations of inflammation; however, this inflammation indicator is non-specific and could

reflect various disorders such as dystocia, mastitis, metritis or displaced abomasum. Despite its non-specific nature, haptoglobin may also have utility for monitoring transition cows.

Currently the strongest data exists for the use of NEFA and BHBA testing in transition dairy cows. 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)

- 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 (Roberts et al., 2012)

- Decreased milk production (Ospina et al., 2011; Chapinal et al., 2012)

- Deceased reproductive performance (Ospina et al., 2011)

‣ Subclinical ketosis (BHBA > 1200–1400 µmol/L) in early lactation is associated with:

- 3 to 8 times increased risk of LDA (Geishauser et al., 2000b; LeBlanc et al., 2005; Duffield et al., 2009)

- Increased risk of metritis (Duffield et al., 2009)

- Decreased probability of pregnancy at first AI (Walsh et al., 2007; Ospina et al., 2011)

- Decreased milk production (Duffield et al., 2009; Ospina et al., 2010; Chapinal et al., 2012)

- Increased duration and severity of mastitis (Suriyasathaporn, 2000)

Specific Strategies for Monitoring NEFA and BHBA

Cow selection

By most definitions, the theoretical testing period for transition cows would extend from 3 weeks prior to calving until 3 weeks after calving. Practically, however, the most important time periods are during the last week before calving and within the first 2–3 weeks after calving.

Precalving

It is unusual for cows to develop subclinical ketosis (SCK) precalving because the etiology of the condition depends on the homeorhetic drive for milk production. However, cows in an energy deficit precalving will start mobilizing energy reserves in the final week before parturition. This can be measured via serum or plasma NEFA. The challenge for this precalving sample is predicting when the animal is going to calve. In the past, establishment of a serum bank and retrospective submission of samples relative to calving have been recommended. However, recent data suggest that assessment of samples obtained within a week of expected calving is a practical approach that seems to provide meaningful information (Leblanc et al, 2005).

Postcalving

A routine ketone testing program should commence after calving. The primary risk period for SCK is the first month of calving. The first 2 weeks postcalving is the time of peak incidence. In addition, the median days from calving to diagnosis of clinical ketosis and displaced abomasum is around 11 days. Thus, in order to try to prevent subclinical disease from becoming clinical disease (if that is possible), cows must be identified earlier. For these reasons, a SCK monitoring program should focus on the first 2 to 3 weeks of lactation.

Required sample size

The number available for testing depends on the herd size. For both BHBA and NEFA it is proportion rather than mean measurements that are important. A good thumb rule for evaluating a herd is to interpret data based on 12 samples. In small herds, this may require repeated sampling over time.

Test selection NEFA

This test should only be used precalving on samples obtained within 1 week of expected parturition. It can be used within 2 weeks of parturition based on the work of Ospina et al. (2011) but a lower cutpoint of around 0.3 mmol/L should be used. The data for NEFA is frequently right skewed and thus averages can be very misleading. One suggested threshold is 0.5 mEqL. In recent work, cows within 1 week of calving with serum NEFA above this threshold were at 3.6 times greater risk of subsequently developing a displaced abomasum (Leblanc et al, 2005). Whole herd interpretation is best made by calculating a proportion of cows above a threshold value; however, there are limited data on an appropriate goal for this parameter. In a multi-herd 1060 cow study near Guelph, 30% of cows were above 0.5 mEq/L during the last week before calving (Leblanc et al., 2005).

The potential of NEFA as a monitoring tool is further highlighted by research conducted at the Elora dairy research center (Osborne, 2003). Of 136 transition cows evaluated, 24 had BHBA concentrations $\geq$ 1400 μmol/L of

serum in the first week post-calving (17.6%). There was a significant association between NEFA concentration in the week before 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 (Osborne, 2003). Our research group currently uses 0.4 mmol/L for cows in the last week prior to expected calving and 0.3 mmol/L for cows two weeks prior to expected calving for all research and herd investigations.

Test selection 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 µmol/L BHBA or greater (Duffield, 2000). A reasonable goal is to have less than 2 cows per 10 with BHBA above 1400 µmol/L in the first 2 weeks post-calving. Many other studies have been conducted and threshold ranges can be defended between 1000 and 1400 µmol/L depending on study and outcome. Our research group has been using 1200 µmol/L for recent research and for herd investigations.

Sample Timing and Handling
Both NEFA and BHBA can be measured in 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. The NEFA concentrations could be slightly falsely elevated if serum was 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 storage at room temperature for 1 day or refrigerated for < 3 days does not substantially affect results (Stokol and Nydam, 2004).

Cow-side tests

Milk ketone tests
Most milk ketone tests measure acetone and acetoacetate through a reaction with nitroprusside that 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 the milk

ketone test that measures BHBA. It was once 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. Canwest DHI has recently launched a milk BHBA test available on herd DHI testing. This test measures milk BHBA accurately and is a reasonable tool for assessment of herd risk for ketosis. However, since the intensity of herd testing is 30 to 40 days and the primary risk period for ketosis is the first two weeks postcalving, this testing system does not replace on-farm testing programs.

Urine ketone tests
The urine ketone tablet tests are based on the same nitroprusside reaction as the milk ketone tests. These tests are highly sensitive (approaching 100%) but are poorly specific which means that 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. Recent work out of Minnesota suggests that a 5 to 10 second interpretation using the Ketostix in urine is just as accurate as the Keto-Test in milk (Carrier et al., 2005).

Blood tests
The human device Precision Xtra glucometer used with the ketone strips (sold by Abbott laboratories) is a highly accurate cow-side test for measuring blood BHBA. This test is the most accurate cow-side test available.

■ Prevention of Transition Cow Problems

Management Guidelines for Transition Cows

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 (DMI) and to provide optimal 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. Strategies for prevention of hypocalcemia are similar with the added attention to potassium concentration in the diet and possibly managing the diet through dietary cation anion balance. The challenge with adding anionic feed additives to the dry cow diets is the attention to detail required for successful implementation. Many farms simply do not have the management skills or resources to effectively utilize this tool and in fact may limit intake by over-acidifying the dry cow diet. Maximizing DMI 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 cow diets, particularly in the early dry period, and for maintaining rumen fill. These diets are aimed at reducing the risk of increased insulin resistance, a suspected cause of so-called 'Type-II' ketosis. However, the main advantage of these diets is limiting energy in the first half of the dry period. One must remember that NDF still limits intake; so excessively high NDF diets can reduce or limit DMI. Additionally, challenges exist, particularly in smaller herds, in the compromise between the correct energy concentration in the diet for a one-group dry cow diet and provision of a diet that allows a smooth transition onto the lactating cow diet. Too high an energy concentration and cows gain weight and the 'low-energy' dry cow diet is ineffective. Too low an energy concentration and there could be rumen adaptation issues onto the highly digestible and higher starch lactating cow diet. For these reasons, many herds have reverted back to a more traditional two-group dry cow approach, but with renewed emphasis on a low energy far-off diet. Osborne (2003) indicated that 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. 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.

Prevention Tools for Transition Cows

In addition to good nutrition, certain products are 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 (Christensen et al., 1995). 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-analyses of monensin studies in lactating dairy cattle has clearly demonstrated that monensin through the transition period reduces BHBA, NEFA, and acetoacetate, and increases glucose (Duffield et al., 2008a,b,c). These improvements in metabolic parameters result in a reduced

risk of clinical disease, including reductions in the incidence of displaced abomasum, clinical ketosis, and mastitis. In addition, cows administered monensin through transition produce significantly more milk, particularly those cows at highest risk of ketosis. Monensin delivered through a controlled-release capsule is more consistent at improving metabolic indicators of health. For most effective control the monensin capsule should be administered precalving (ideally 3 to 4 weeks prior to expected calving).

Rumen protected choline has been shown to influence liver glycogen and triglyceride (Piepenbrink 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 DMI through transition with the feeding of yeast products. However, impacts on metabolic parameters and clinical health outcomes have not been investigated to date.

■ Conclusions

Herd variation for metabolic disease incidence problems is wide and herd level risk factors are poorly described. Herd level risk factors most likely involve combinations of management, feed quality and nutritional programs, cow comfort, environment, and other variables that influence DMI. Routine monitoring programs for subclinical ketosis are beneficial on many dairies and can serve as an important early warning system for metabolic disease problems, as well as a highly useful means of assessing effects of management or nutritional changes.

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