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Monitoring strategies for metabolic disease in transition dairy cows

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Introduction

Most periparturient abnormalities have some metabolic element as a component of the sufficient 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.

Subclinical disease incidence is far more common than clinical disease, frequently goes unnoticed and may be associated with significant clinical disease risks, impaired production and reduced reproductive performance. Prevention depends on several factors including proper transition cow nutrition and management, control of body condition; and may be helped through the use of certain feed additives such as propylene glycol, rumen protected choline and ionophores. This article will focus on monitoring strategies for subclinical ketosis (SCK).

Monitoring subclinical ketosis

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 prior to calving and within the first 2 weeks after calving.

Precalving

It is unusual for cows to develop 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 non-esterified fatty acids (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, evaluation of our own data suggests that assessment of samples obtained within a week of expected calving is a practical approach that seems to provide meaningful information.

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 early. For these reasons, a SCK monitoring program should focus on the first 2 to 3 weeks of lactation.

Test Selection

NEFA
This test should only be used precalving on samples obtained within 1 week of parturition. Unfortunately these restrictions make the utility of this test limited to certain situations such as a herd investigation or an intervention follow-up. Recently, however, we have observed that using sera data from cows within 7 days of expected calving (rather than actual calving) is a practical approach that yields similar information to retrospective analysis to banked sera. The data for NEFA is frequently right skewed and thus averages can be very misleading. One suggested threshold is 0.5 units/L. In recent work, 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.[1] 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. [1]

The potential of NEFA as a monitoring tool is further highlighted by recent work at our Elora dairy research center.[2] Of 136 transition cows evaluated, 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).[2]

Serum 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. Although BHBA is the most stable of the ketones, it is the most subject to variation associated with feed intake, thus all samples on a given farm should always be taken at the same time of day. In addition, hemolysis is known to artificially elevate values, therefore, hemolyzed samples should be avoided. Other disadvantages of serum BHBA is the cost (approx $5.00 per sample) and the laboratory turn around time (minimum 24 hours). However, all things considered, serum BHBA analysis is the gold standard from which to compare cowside tests. 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.

Milk Ketone Tests
Most milk ketone tests measure acetone and acetoacetate through a chemical reaction with nitroprusside which causes a colour change from white to either pink or purple. These tests in

general are poorly sensitive in milk (<40%) but highly specific (>90%).[3,4] One exception is the milk ketone test that measures BHB. 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%).[2,4,5] 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 tests are highly sensitive (approaching 100%) but are poorly specific.[2] 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. If the urine test was used to evaluate the goal of less than 2 cows per 10 with BHBA above 1400 umol/L in the first 2 weeks post-calving, an adjustment of the goal to less than 5 cows per 10 with positive urine ketone tests would be required (see table 1). However, recent work out of Minnesota suggest that a 5 second interpretation using the Ketostix in urine is just as accurate as the Keto-Test in milk.[6] More work needs to be done to fully assess the utility of urine ketone tests.

Table 1. Use of Cowside Ketone Tests in Screening Programs for Identifying Subclinical Ketosis.

Test	20% Prevalence			40% Prevalence			60% Prevalence		
	PV +ve	PV -ve	Apparent Prevalence	PV +ve	PV -ve	Apparent Prevalence	PV +ve	PV -ve	Apparent Prevalence
Keto-Test® using 100 μmol/L	62%	93%	23%	81%	83%	35%	91%	68%	48%
Ketocheck™ (milk)	90%	86%	8%	96%	70%	16%	98%	51%	23%
Urine Acetest Tablet	38%	100%	53%	62%	100%	65%	78%	100%	76%

PV +ve: Predictive Value of a positive test result.
PV –ve: Predictive Value of a negative test result.

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. Note from Table 1 that the urine ketone test would substantially overestimate the prevalence of subclinical ketosis, while the Ketocheck™ test would grossly underestimate the prevalence. This does not preclude these tests from being used. However, the impact of the inherent

sensitivity and specificity of the test must be incorporated into establishing goals, and intervention thresholds.

Herd Disease Records

Herd records are important tools for monitoring the incidence of periparturient disease. 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 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 NEFA precalving will have suboptimal dry matter intake. In a recently completed project, serum BHBA concentration in the first week post-calving was significantly associated with the average DMI in the week prior to calving.[2] 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 week 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).[2] 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 are generally less useful because we are primarily interested in the intakes of cows within the first three weeks postcalving. If a fresh cow group exists, it is often composed of cows that may be several months postcalving.

DHI Test Day Data

Since milk fat and milk protein percentages are altered in subclinical 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.[7] However, the protein to fat ratio was not a good test overall, having a sensitivity of 58% and a specificity of 69%.

Identifying High Risk Herds

Can herd incidence of certain diseases be used 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 had a BCS ≥ 4.0 at 3 wks precalving, that herd was extremely likely to have a problem with subclinical ketosis.

Economics of Monitoring

For the herd level monitoring interpretation, the savings achieved is in identifying a problem sooner rather than later, since nearly all problems will eventually be identified. A conservative estimate of the economics of a biweekly program suggests that a routine monitoring program would payback if one major problem was identified earlier than traditional means every 4 to 5 years. The economics of individual cow testing depends on the efficacy of treatment, accuracy of the test, cost of the therapy and prevalence of disease. [8]

Conclusions

Subclinical ketosis is an important and common disease in lactating dairy cows. Prevention depends largely on effective dry cow nutrition and management. Given the cost of subclinical ketosis, the fact it is a common problem in early lactation, and the strong association with clinical disease, monitoring programs for subclinical ketosis during the first few weeks of lactation may be warranted. There are several cowside tests for subclinical ketosis available, however, all of the current tests have their strengths and weaknesses. The design and frequency of a subclinical ketosis monitoring program will depend on the purpose of the program and the frequency of disease within the herd.

Abstract

Les programmes de monitoring de la balance énergétique négative et de l'acétonémie subclinique sont des activités rentables pour les troupeaux laitiers et permet l'identification des individus malades et la surveillance des performances des vaches en phase de transition. Les programmes devraient être centrés sur la surveillance des AGL (acides gras libres) et lors de la consommation volontaire de matières sèches au cours de la période précédant le vêlage. Les programmes de monitoring post-vêlages devraient être ciblés durant les deux premières semaines de la lactation. Plusieurs outils diagnostiques utilisés en période post-partum sont présentés et discutés dans le texte.

References

1. LeBlanc S., Duffield, T., Leslie, K. Metabolic predictors of displaced abomasums. J. Dairy Sci. 2004 submitted.
2. Osborne, T.M. An evaluation of metabolic function in transition dairy cows supplemented with Rumensin premix or administered a controlled-release capsule. MSc dissertation, University of Guelph, 2003.

3. Duffield, T. Effects of a monensin controlled release capsule on energy metabolism, health, and production in lactating dairy cattle. DVSc dissertation, University of Guelph, 1997.
4. Geishauser T., Leslie K., Kelton D., Duffield, T. Evaluation of five cowside tests for use with milk to detect subclinical ketosis in dairy cows. J. Dairy Sci. 81: 438-443, 1998.
5. Belanger AM, DesCoteaux L, Couture Y, Baril J, Bagg R. Evaluation of a milk strip test for detection of subclinical ketosis at cow level. In : Proceedings of the 36th Ann Conv Am Assoc Bov Pract 2003; 174
6. Carrier, J., Stewart, S., Godden, S., Fetrow, J., and Rapnicki, P. 2003. Evaluation of three cow-side diagnostic tests for the detection of subclinical ketosis in fresh cows. In Proc. 4-State Applied Nutrition and Management Conference. La Crosse, WI. July 9-10, 2003.
7. Duffield, T.F., Kelton, D.F., Leslie, K.E., Lissemore, K., Lumsden, J.H. Use of test day milk fat and milk protein to predict subclinical ketosis in Ontario dairy cattle. CVJ 38:713-718, 1997.
8. Geishauser, T., Leslie, K., Kelton, D., Duffield, T. Monitoring for subclinical ketosis in dairy herds. Compendium of Continuing Education. 23: s65-s71, 2001.