River Valley Veterinary Clinic
May 2017 Newsletter

Ketosis Within the Cow

Ketosis has become the most significant metabolic disease of dairy cattle in the US, surpassing ruminal acidosis and milk fever in the 1990s. While incidence in a given herd is difficult to estimate without regular surveillance and testing, some 30% of all dairy cows are affected at some point in their early lactation. Yet only 3% of cows show any clinical signs, are diagnosed and treated. It is a disease that begins in dry cows and shows up in fresh cows when they suddenly require and use lots of energy

A cow's risk period for developing ketosis after calving begins during the preceding dry period. She needs to maintain or increase her energy intake while dry to prepare for milk production, but her dry matter intake (DMI) naturally decreases in the final month prior to calving and noticeably so about 5 days pre-calving. If the cow's energy intake going into her lactation is low, the sudden demand for energy to make milk will be difficult to meet, and ketosis may result. Therefore, every step must be taken to minimize factors that would reduce her feed intake during the dry period. These would include: any pen moves too close to calving or even too frequently afterward; adding individual cows to established groups; and over-crowded pens. Basically, anything that would physically prevent cows from getting easily up to the bunk or that would stress them out too much to eat must be avoided. A dirty, crowded maternity pen will decrease their intake at a time when they need 24-hour access to feed and water. With the decrease in DMI, a high nutrient density feed should maintain energy intake. But even that won't help the cow if she doesn't eat. Over-conditioned dry cows are more likely to decrease their feed intake around calving, as are especially thin cows.

After calving, the energy required for milk production often exceeds the energy intake, and the cow enters a Negative Energy Balance where she must begin mobilizing energy stored in her body fat to maintain milk production. During normal digestion, ruminal microbes break down the plant fibers and produce four Volatile Fatty Acids (VFAs): propionate, butyrate, acetate and oxaloacetate. The cow can absorb the VFAs and convert them to usable energy. Propionate is the easiest to convert, while butyrate and acetate metabolism has an additional step that requires a metabolite of the fourth VFA, oxaloacetate. However, the mammary gland has priority in using propionate and oxaloacetate to make lactose. This leaves butyrate and acetate without a way to become energy since oxaloacetate is unavailable. The body is forced to route butyrate and acetate through a less efficient cycle to make energy, which produces ketones as an unusable byproduct. Cows produce three ketones that come into play when measuring the severity of ketosis: acetone, acetoacetate and BHBA. These ketones circulate in the bloodstream and cause problems.

During fat mobilization, the body converts the stored fat to a form that can travel through the blood to the liver to be processed, called a non-esterified fatty acid (NEFA). Once at the liver, if the VFA oxaloacetate is available, the fat is efficiently made into usable energy. If not, it is routed through the less efficient cycle and produces less energy and ketones. However, the liver in a ruminant is slow at processing NEFAs and getting them out of the liver, so they build up in the liver disrupting liver function and damaging cells. This fat build-up in the liver is appropriately called Fatty Liver and causes chronic, possibly deadly, problems in a fresh cow. When a cow returns to a Positive Energy Balance, where her energy needs are met by her intake, ketones will no longer be produced. The liver will no longer be inundated with NEFAs giving it a chance to process what is already there and export it, which can take weeks.

A ketotic cow has very few obvious symptoms, usually limited to a decrease in feed intake, low milk and possibly lethargy, which is why cow-side tests are critical. With exceptionally high levels of ketones, a cow can develop nervous ketosis and be uncoordinated, aggressive, bellow or obsessively lick or chew on random objects. A cow with fatty liver is often over-conditioned and her initial symptoms are the same but with a persistent ketosis.

Some lucky (or unlucky?) people can detect the sweet smell of ketones on a cow's breath, but for the rest there are three ways to check a cow's ketones: through her urine, milk or blood. The gold standard ketone test is through a blood sample sent to a diagnostic lab to measure the BHBA level, which is the main ketone produced by dairy cows. Anything over 1.2 mmol/L is ketosis and sets the precedent for the other tests. Urine ketones are tested with Ketostix test strips which measure acetoacetate from a stream of urine. They need to be read within 10 seconds to avoid a false positive and a "Small" test result or higher is diagnostic for ketosis. The main issue with the urine strips is that the cow must urinate to be tested, and only 40-60% will urinate when stimulated.

The Keto-Test milk strips measure BHBA and are read after 60 seconds. The cutoff is 100 umol/L; anything greater is diagnostic for ketosis. Both urine and milk strips are about equal in their ability to detect ketosis, but the milk strips are more likely result in a few more false positives, that is, to call a few more negative cows ketotic than the urine strips.

A test that has gained momentum in the last five years is the hand-held BHBA blood meter. They are the same meters as used by human diabetics to test blood sugar, but different strips are used that measure BHBA in the blood. A small blood sample is taken from the tail vein with a thin needle and a drop of blood is placed on the strip. Within ten seconds the result is displayed and is by far the most accurate cow-side test. A result of 1.2mmol/L or higher is diagnostic for ketosis. The price of the meter and strips fluctuates, but right now it is less than $100 for the meter and about $1 per strip. The meters make monitoring quick and easy in fresh cows so that ketosis is caught and treated earlier and so that the consequences of untreated ketosis, such as a displaced abomasum, are minimized.

The theory behind ketosis treatment is to provide the cow with alternative sources of glucose, which is an easy form of energy for the cow to make. The type of glucose given is based on the severity of her ketosis. See the chart below for a breakdown of test results and the associated severity of ketosis. Mild cases of ketosis can be treated orally with propylene glycol, which is an glucose precursor, 4-8oz twice daily for 3-5 days or until she tests negative. Moderate and severe cases require IV dextrose which is easily converted to glucose. In very severe cases, a cow may need dextrose daily for 2-3 days, but follow the advice of the veterinarian: too much dextrose can be harmful and increase the chance of a relapse or a displaced abomasum. Vitamin B12 is an important part of energy metabolism, so 10-15mL of Vitamin B Complex is added to the dextrose to be given IV.

Dexamethasone is occasionally used in severe cases for its ability to increase blood glucose by reducing insulin response, decreasing milk yield and increasing glucose production. However, it isn't an ideal way to move glucose around in a fresh cow, so shouldn't be used if the cow is less than three weeks in milk as it could contribute to the development of fatty liver. Dextrose should be followed up with propylene glycol daily and the cow should be tested and treated appropriately until she is negative. A nutritional supplement in the form of an alfalfa drench in 10 gallons of water contain glucose precursors as well as a source of energy to help the cow return to a Positive Energy Balance. The most important thing for a ketotic cow to do is start eating! Chronically ketotic and fatty liver cows are treated in the same manner, but for a longer period with daily dextrose and alfalfa drenches. The prognosis of a fatty liver cow is poor to grave and requires constant treatment, but if she can make it to about 50 days in milk when she hits peak production, she will probably survive.

A 2015 study at Cornell University calculated the cost per case of ketosis at $375 for first calf heifers and $256 for second lactation and higher cows. This estimate takes into consideration the direct cost of testing, treatment, milk lost during withholds and DA surgery as well as indirect costs such as future reproduction and milk losses, and death or culling losses. While it is a fresh cow disease, the dry period is the most important part of prevention through low-stress environments and excellent nutrition.

Ketosis Test	**Ketostix strip**	**Keto-Test strip**	**Blood Meter**
Ketone Detected:	Acetoacetate	BHBA	BHBA
Test Sample:	Urine	Milk	Blood
Ketosis Level:			
No Ketosis	"Negative" "Trace"	"Negative"	<1.2mmol/L
Mild Ketosis	"Small"	+/-	1.2-2.5mmol/L
Moderate Ketosis	"Moderate"	+	2.5-3.5mmol/L
Severe Ketosis	"Large"	++	>3.5mmol/L