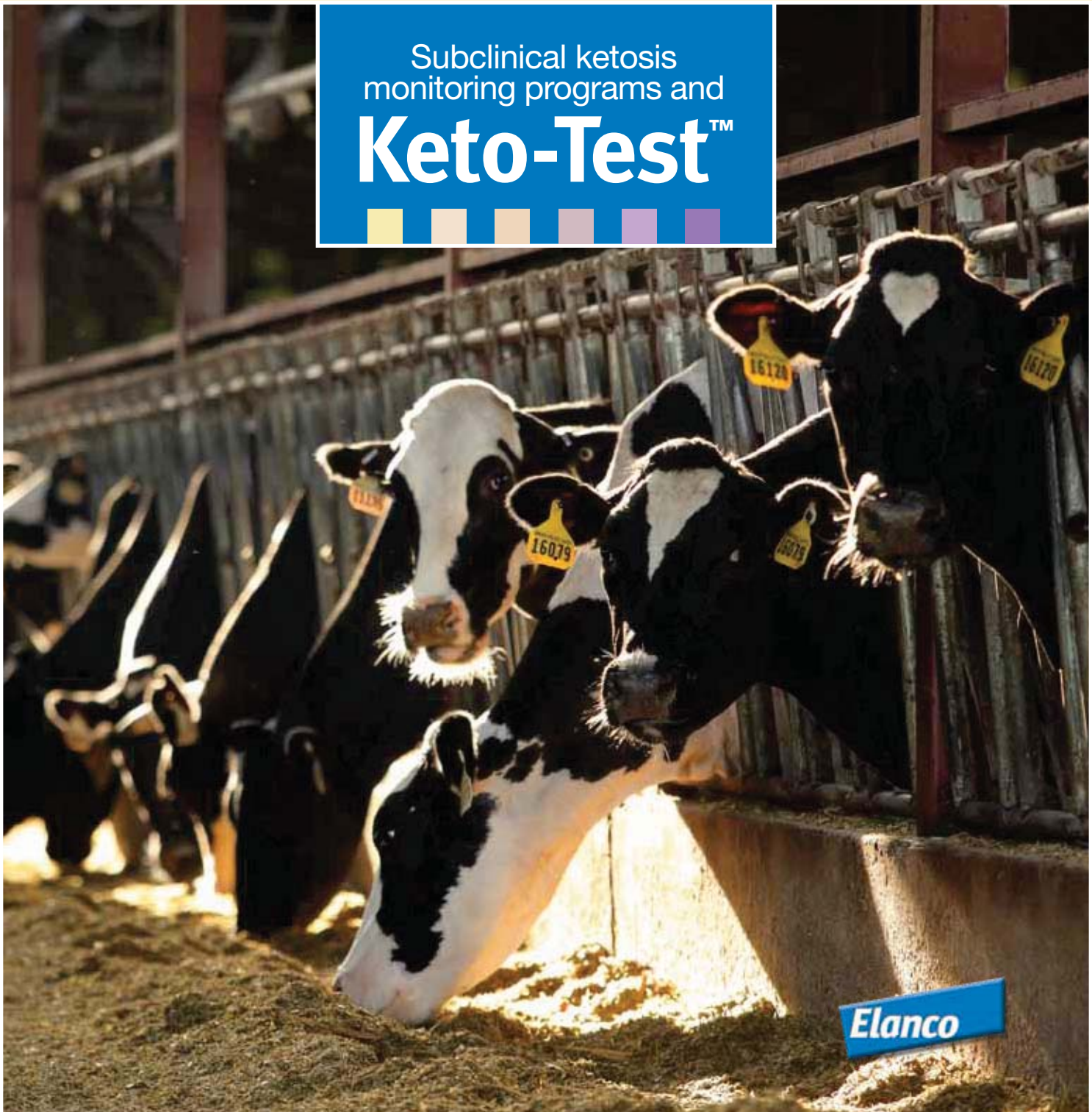
Subclinical ketosis monitoring programs and Keto-Test™



KEY MESSAGES

- The Keto-Test strip allows for simple, low-cost testing of milk for subclinical ketosis as a herd screening tool or individual cow-side test.
- Keto-Test enables easily implemented herd-level testing every second or third week of all cows that are 2 to 21 days in milk.
- Using Keto-Test for monitoring the incidence of subclinical ketosis can be useful for evaluating a transition cow program.
- Producers should work with their veterinarian and nutritionist to develop the right herd-monitoring program for their dairy operation.

WHAT IS KETO-TEST™?

Keto-Test is a semiquantitative, colorimetric test that measures the level of beta-hydroxybutyrate (BHBA) in milk. It is a useful diagnostic tool for determining if individual cows or herds are experiencing elevated levels of ketones *(see insert)*.

TESTING STRATEGIES

Cows in early lactation are in negative energy balance due to low dry matter intake relative to milk production. Negative energy balance causes fat mobilization, which can subsequently lead to elevated ketone bodies (BHBA, acetone, and acetoacetate). Elevated ketones can lead to other periparturient conditions such as fatty liver syndrome, clinical ketosis, and displaced abomasum.[1] Dairies can benefit from a postpartum monitoring program that measures BHBA levels, potentially signaling excessive negative energy balance and ketosis. Testing for BHBA can be directed at either the cow level or the herd level.[1]

Cow level: early identification of individual cows

Monitoring programs, which include collection of body temperature, evaluation for rumen fill, examination for uterine discharges, and examination for abnormal milk, have become common practice in many dairy herds. Keto-Test can be used in a fresh-cow monitoring program as a simple alternative to other ketone tests, which use urine or blood samples. This monitoring can be targeted for potential problem or high-risk cows.

The objective of testing individual cows is to identify those with ketosis early in the disease process so more severe clinical disease can be avoided with clinical intervention. For this program to be successful, cows must be tested regularly (repeatedly) during early lactation.

Herd level: early identification of transition management problems

The primary objective for a herd-level monitoring program is identification of problems during transition, before they become major problems. Herd-based testing differs from individual cow testing in that a sufficient number of cows must be routinely tested to validate results. Subclinical ketosis is a threshold disease with cows considered positive only when ketones are elevated to a predetermined concentration.[2] Intervention should be considered when a significant proportion of cows exceed a specific cut point. A herd-level testing strategy for Keto-Test could include testing all cows that are 2 to 21 days in milk every second or third week. If more than 10 percent to 20 percent of the population of cows have weak positive test results (> 100 µmol/L), this suggests a potential problem and the herd veterinarian or nutritionist should be consulted.

WHAT IS KETOSIS?

Ketosis is defined as cows experiencing abnormally high concentrations of circulating ketone bodies (e.g., blood BHBA > 1200 µmol/L) which may lead to anorexia, firm dry feces, reduced milk production, and secondary conditions such as displaced abomasums. Clinical ketosis indicates that the condition is severe enough for clinical signs to be observed while subclinical ketosis (SCK), as the name implies, indicates the cow is suffering from elevated serum BHBA but clinical signs are not obvious. The difference between clinical and subclinical may simply be the level of observation or interpretation of signs. Ketosis typically occurs in early lactation when animals are in negative energy balance.[3]

HOW COMMON IS SUBCLINICAL KETOSIS?

The overall prevalence of SCK is estimated to be approximately 15 percent of early-lactation, at-risk cows[2] although true incidence is variable and is higher in some herds. A recent survey of 60 herds conducted by Cornell University[4] showed that, in 40 percent of the herds, greater than 15 percent of the cows sampled had serum BHBA concentrations > 1200 µmol/L. To convert µmol/L to mg/dL, divide by 96.05.[5]

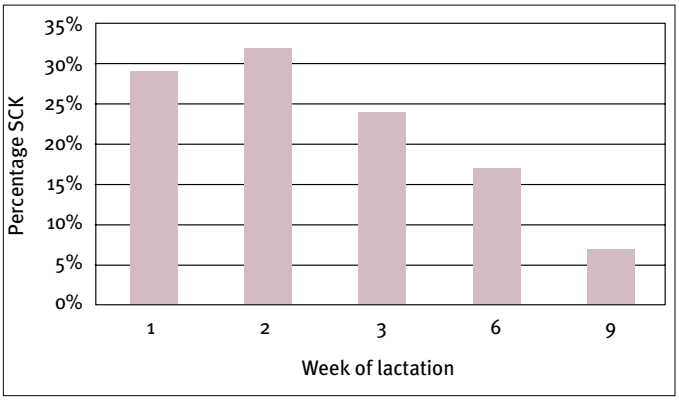
THE COST OF SUBCLINICAL KETOSIS

Total economic losses for clinical and subclinical ketosis are similar and include decreased milk production, increased risk of displaced abomasums, and impaired fertility.[1,4,6] In 2001, Geishauser and coworkers[6] estimated the cost of a single case of SCK to be $78 per cow in treatment costs or approximately $97 in today's dollars.

WHEN TO TEST FOR SUBCLINICAL KETOSIS

Most cases of ketosis occur in the first few weeks of lactation. A large field study[7] demonstrated that the highest percentage of SCK (more than 30 percent) occurred during the second week of lactation *(Figure 1)*. Results from this study suggest the best time to test for SCK is during weeks one to three post calving. Another study[8] showed approximately 92 percent of the positive ketosis test results occurred during the first 65 days of lactation. Keto-Test is an easy-to-use cow-side test, which measures BHBA levels in milk. Using Keto-Test as a herd-screening test, a dairy can routinely monitor fresh cows for incidence of ketosis *(see testing strategies, at left).*

Figure 1
Percentage of cows with subclinical ketosis (SCK) by week of lactation



Percentage of cows with SCK by week of lactation determined by blood BHBA >1200 µmol/L.
Adapted from Duffield et al.[1]

Table 1
Sensitivity and specificity for Keto-Test reported in the literature‡

Study	Herds	Samples	DIM[a]	SE[b]	SP[c]	Prev[d]
Belanger[10]	1	55	2-21	93%	68%	25.4%
Carrier[5]	1	850	2-15	73%	96%	7.6%
Oetzel[2]	17	221	NR*	87%	83%	17.2%
Osborne[11]	1	248	1-15	95%	69%	16.5%
Geishauser[12]	21	469	1-7	80%	76%	12.0%

‡ Using 100 µmol/L as the cut point for the test
[a]Days in milk when testing was conducted
[b]SE=sensitivity
[c]SP=specificity
[d]Prev=prevalence of subclinical ketosis for that study
*NR=not reported

DIAGNOSIS OF SUBCLINICAL KETOSIS

Diagnosis of SCK can be made utilizing one of the following methods:

Blood BHBA

Determination of levels of BHBA in blood is considered the "gold standard" for identifying SCK. Blood BHBA concentrations between 1100 and 1400 µmol/L are considered consistent with SCK.[2,4] In herd-based testing programs, an alarm level for the proportion of cows above a specific level has not been well defined. Ten percent of cows tested exceeding 1400 µmol/L level has been suggested as being significant,[2] whereas others[4] have suggested 15 percent exceeding 1100 µmol/L as being significant.

Urine ketone tests

Urine ketone tests have been relatively popular due to their low cost and ease of conducting the test. However, urine collection can be a time-consuming and difficult procedure in some cows. Also, unlike collection of milk or blood, urine sample collection may not be possible from the entire desired population. The urine ketone tests are semiquantitative tests based on degree of color change that occurs when sodium nitroprusside reacts with acetoacetate and, to a lesser degree, acetone.[5] The sensitivity and specificity with the urine strip (Ketostix,® Bayer, Elkhart, Indiana) have been shown to be 90 percent and 86 percent, respectively, at the trace level (approximately 490 µmol/L of acetoacetate),[5] making this the best test for urine.

Milk ketone tests

Most milk ketone tests also utilize the sodium nitroprusside reaction with acetoacetate. In general, these tests have poor sensitivity (40 percent and many false negatives) and good specificity (100 percent with few false positives).[2,4,5] However, the Keto-Test is a milk test that measures BHBA.[9] It has been shown to have greater sensitivity and specificity compared to other milk tests. Table 1 at left shows the sensitivity and specificity results of the Keto-Test in five different studies.

TEST PERFORMANCE

Keto-Test was evaluated in several studies comparing it to serum BHBA levels.[10,11,12] Keto-Test results were found to be effective compared to serum BHBA levels.

In a study evaluating metabolic predictors of left displaced abomasums (LDA), cows with Keto-Test results ≥ 100 µmol BHBA/L milk during the first seven days postpartum were almost three times more likely to develop an LDA one to three weeks later (compared to similar animals with < 100 µmol/L).[13]

Subclinical ketosis is a common problem on the dairy. In one study[4] over 40 percent of the herds surveyed were found to have more than 15 percent of the animals tested with elevated ketone bodies, indicating SCK. The Keto-Test provides a cost-effective screening program that can help determine if further investigation is warranted.

SUMMARY

Using Keto-Test for monitoring the incidence of subclinical ketosis can be a useful tool for evaluating a transition cow program.

The Keto-Test strip allows for simple, low-cost testing of milk for SCK, and thus enables the producer to monitor for the condition by testing fresh cows (2-21 DIM) every second or third week after calving.

Producers should work with their veterinarian and nutritionist to develop a herd-monitoring program that is right for that dairy operation.

The label contains complete use information, including cautions and warnings. Always read, understand, and follow the label and use directions.

[1]Duffield TF. 2007. Peripartum metabolic monitoring. Proc AABP Conference, 40:213-218.

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[7]Duffield TF, D Sandals, KE Leslie, K Lissemore, BW McBride, JH Lumsden, P Dick, and R Bagg. 1998. Efficacy of monensin for the prevention of subclinical ketosis in lactating dairy cows. *J. Dairy Sci.* 81:2866-2873.

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[13]Leblanc SJ, KE Leslie and TF Duffield. 2005. Metabolic predictors of displaced abomasums in dairy cattle. *J. Dairy Sci.* 88:159-170.

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