Prevention and Prediction of Displaced Abomasum in Dairy Cows*

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Abstract

The objective of this article is to summarize studies that have been conducted on the prevention and prediction of displaced abomasum in dairy cows. Our findings indicate that displaced abomasum is a moderately heritable trait. Subclinical ketosis is a significant risk factor of displaced abomasum. Thus, displaced abomasum incidence might be lowered by genetic selection and by prevention of subclinical ketosis. To predict displaced abomasum, aspartate-aminotransferase activity in blood, ß-hydroxybutyrate concentration in blood and milk, and the fat-protein-ratio in milk may be used. All of these parameters are frequently increased prior to the diagnosis of displaced abomasum.

Introduction

Displaced abomasum (DA) causes economic losses due to treatment costs, discarded milk, decreased milk yield and increased risk of removal from the herd (Martin et al. 1978, Milian-Suazo et al. 1988, Bartlett et al. 1995, Geishauser et al. 1998b). In the lactation in which DA was diagnosed losses ranged from US$ 250 to US$ 400 per case, depending on the technique used for surgery (closed or open) (Bartlett et al. 1995). In North America there are about 11 million dairy cows. Given a conservative average DA lactational incidence rate of 2% (Kelton 1995), about 220,000 cases of DA occur per year, resulting in annual losses of about $55 to 88 M (US). With a higher average incidence rate of 5% (Duffield 1997), about 550,000 cases of DA would occur, causing annual losses of about $137 to 220 million (US). Considering these economic losses, it is surprising means for prevention and monitoring of DA are not well described (Geishauser 1995).

Prevention

In a study conducted in Hessia, Germany, DA was most frequently diagnosed in Black Holsteins (Geishauser et al. 1996a). The degree of heritability of DA was estimated at 24% in Black Holstein herds using the similarity between mothers and daughters (Geishauser et al. 1996b). In Ontario, Canada, the degree of heritability of DA was estimated at 28% in Black Holstein herds, using the similarity between fathers and daughters (Uribe et al. 1995). From these studies, it was suggested that in these regions and breeds, DA is a moderately heritable trait. The incidence of DA may be lowered by genetic selection (Uribe et al. 1995, Geishauser et al. 1996b). It was recommended not to breed cows affected with DA (Geishauser et al. 1996b).

Aspartate-aminotransferase (AST) activity, the concentrations of ß-hydroxybutyrate (BHB) and glucose, and body condition score were evaluated three weeks prior to calving, as well as in the first and second week after calving in case or control cows that were subsequently diagnosed with DA or not, respectively. Three weeks prior to calving all of the above parameters were normal in cows diagnosed with DA four to seven weeks later (Fig. 1 to 3). However, AST and BHB were significantly increased in the first and second week after calving in cows diagnosed with DA one to three weeks later as compared to control cows (Fig. 1 and 2) (Geishauser et al. 1998c). If blood AST activity in the first week post partum was ≥1700 nkat/l, the odds were three to one

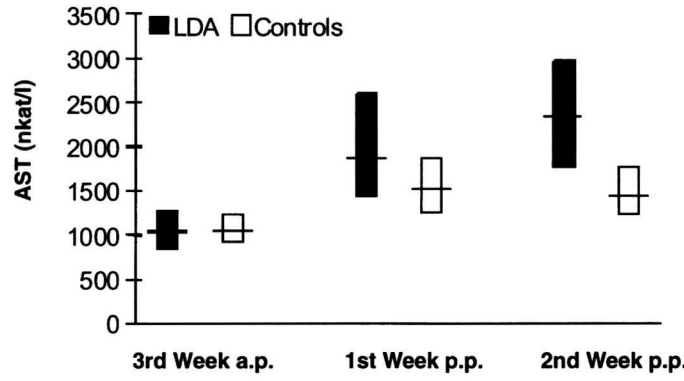

Figure 1. AST activity in blood three weeks ante partum (a.p.), and in the first and second week post partum (p.p.) in cows subsequently diagnosed with DA (■) and in herdmates not diagnosed with DA (□). Median and interquartile range are given (Geishauser et al. 1998c).

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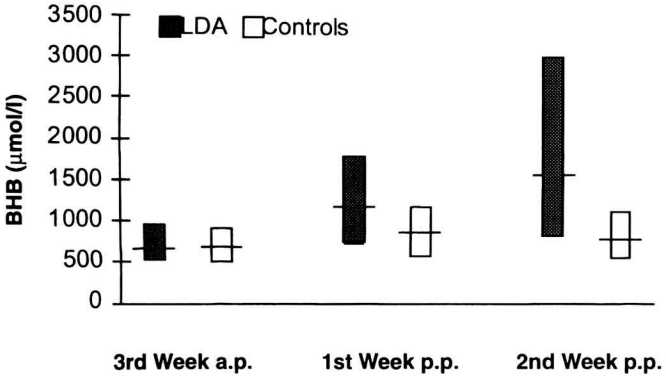

Figure 2. BHB concentration in blood three weeks ante partum (a.p.), and in the first and second week post partum (p.p.) in cows subsequently diagnosed with DA (■) and in herdmates not diagnosed with DA (□). Median and interquartile range are given (Geishauser et al. 1998c).

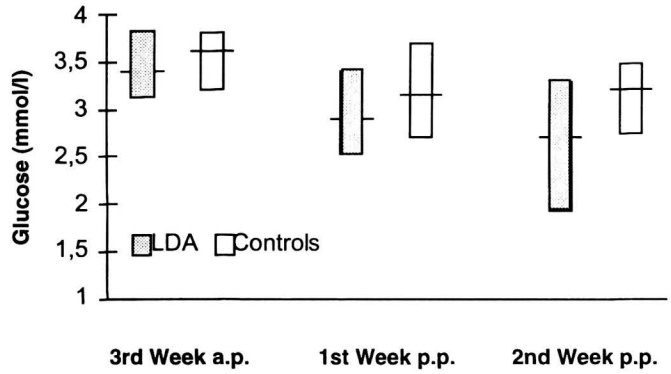

Figure 3. Glucose concentration in blood three weeks ante partum (a.p.), and in the first and second week post partum (p.p.) in cows subsequently diagnosed with DA (▒) and in herdmates not diagnosed with DA (□). Median and interquartile range are given (Geishauser et al. 1998c).

(compared to <1700 nkat/l) that DA would be diagnosed one to three weeks later (odds ratio) (in the second week post partum the odds ratio was eight to one). If blood BHB levels were ≥1000 µmol/l, the odds were two to one (compared to <1000 µmol/l) that DA would be diagnosed one to three weeks later (in the second week post partum the odds ratio was four to one) (Geishauser et al. 1997b). Glucose was significantly decreased in the second week after calving, but not in the first week (Fig. 3). Body condition score was unaltered (Geishauser et al. 1998c).

Ketolac® BHB (Hoechst, Unterschleißheim/Germany) is a cow-side test that measures ß-hydroxybutyrate in milk. This test was evaluated during the first two weeks after calving in cows subsequently diagnosed with DA and in control cows. If Ketolac® BHB indicated ≥100 µmol BHB/l milk in the first two weeks post partum, the odds were three to one (compared to <100 µmol/l) that DA would be diagnosed one to three weeks later (Geishauser et al. 1997c).

Daily milk yield, milk fat and protein percentage and milk fat-protein-ratio (FPR) in the first test after calving by the Dairy Herd Improvement (DHI) organization were evaluated in cows subsequently diagnosed with DA and in control cows. One to three weeks prior to DA diagnosis, daily milk yield and milk protein percentage were decreased; milk fat percentage and FPR were increased (Geishauser et al. 1999). If milk FPR was ≥1.4, the odds were two to one (compared to <1.4) that DA was diagnosed one to three weeks later (Geishauser et al. 1997a).

BHB concentrations ≥1000 µmol/l blood (Työppönen und Kauppinen, 1980), Ketolac® BHB findings ≥100 µmol BHB/l milk (Geishauser et al. 1998a) and milk FPR ≥1.4 (Dirksen et al. 1997) may indicate subclinical ketosis. Our findings suggest that subclinical ketosis is a risk factor of DA. Consequently, prevention of subclinical ketosis may prevent DA (Duffield 1997).

Prediction

As previously discussed, metabolic parameters may be used to predict DA. If AST is used as a test for subsequent DA diagnosis, the true positive rate, and the false positive rate, respectively, depend on the the cut-off level used. The true positive rate gives the sensitivity of the test (rate of positive tests in DA cows); the specificity (rate of negative tests in healthy cows) can be used to calculate the false positive rate (1 – specificity). AST findings ≥1700 nkat/l in the first week post partum truely indicated subsequent DA diagnosis in 61% (second week post partum 79%) and falsely indicated DA in 46% (second week post partum 31%) (Fig. 4). BHB findings ≥1000 µmol/l in the first week post partum truely indicated DA

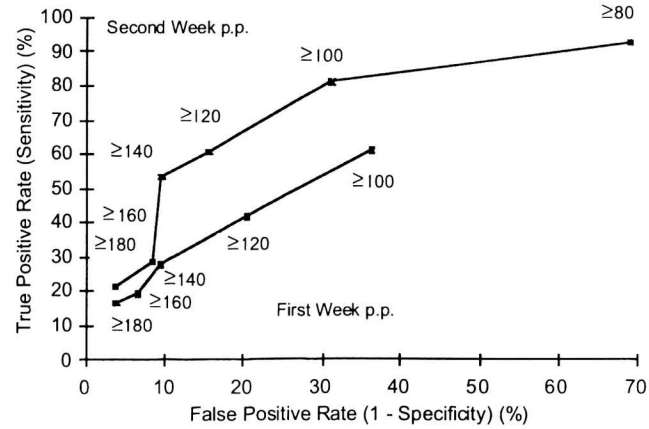

Figure 4. AST activity in blood in the first and second week post partum (p.p.) as a test to monitor for DA. True positive rate and false positive rate at different AST cut off levels (Geishauser et al. 1997b).

in 61% (second week post partum 64%), and falsely indicated DA in 38% (second week post partum: 31%) (Fig. 5) (Geishauser et al. 1997b). Ketolac® BHB findings showing ≥100 µmol BHB/l milk truely indicated DA in 46% and falsely indicated DA in 19% (Geishauser et al. 1997c). A FPR ≥1.4 truely indicated DA in 80% and falsely indicated DA in 31% (Fig. 6) (Geishauser et al. 1997a).

Suppose in a herd of 100 dairy cows the lactational incidence rate of DA diagnosis is 2% (Kelton 1995). All cows are monitored for DA on a regular basis in the first month after calving, because 80% of all DA are diagnosed in the first month after calving (Constable et al. 1992). Cows are monitored weekly using BHB in blood. BHB findings ≥1000 µmol/l are taken as a positive result. This test truely indicates DA in 60% and falsely indicates DA in 30%. In this herd, two cases of DA will be diagnosed per year. Using blood BHB as a test, one DA will be truely predicted but 30 cases will be falsely predicted (Table 1 and 2). Ketolac findings ≥100 µmol BHB/l milk would truely indicate 0.7 DA cases and falsely indicate 19 DA cases. A FPR ≥1.4 would truely indicate 1.3 DA cases and falsely indicate 30 DA cases. We would like to encourage the reader to perform their own evaluation using a spreadsheet (e.g. Excel 7.0, Microsoft Corporation, Seattle/USA) (Table 1).

Hence, the parameters evaluated here for DA monitoring are insufficiently sensitive (low true positive rate), and insufficiently specific (high false positive rate) under normal conditions. However, under certain conditions monitoring cows for DA weekly in the first month after calving may be profitable when using parameters evaluated (sensitivity 80%, specificity 70%) (Table 3) (Geishauser 1998). These conditions include: DA incidence of 20% (Jacobsen 1995), high losses per case (treatment costs, milk losses, stock losses) (Bartlett et al. 1995), test costs less than $0.5 US per test, and effective means to prevent DA in cows at risk (administration of glucogenic substances) (Duffield 1997).

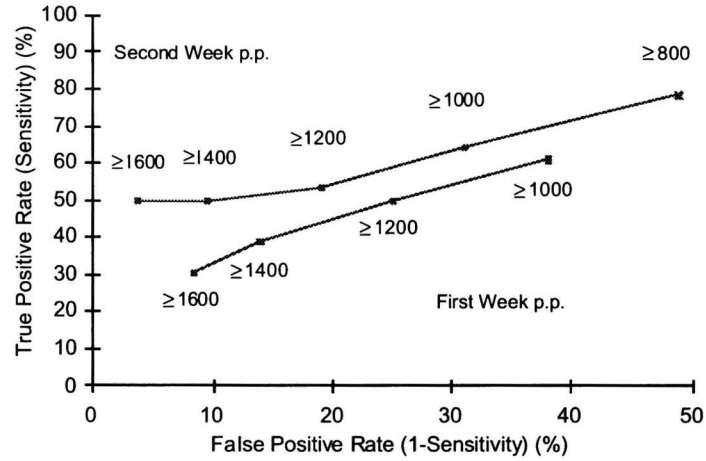

Figure 5. BHB concentration in blood in the first and second week post partum (p.p.) as a test to monitor for DA. True positive rate and false positive rate at different BHB cut off levels (Geishauser et al. 1997b).

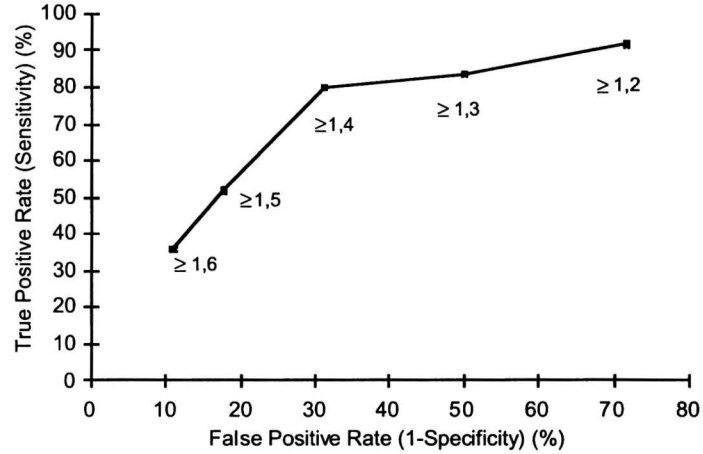

Figure 6. Fat-protein-ratio in milk in the first test after calving by the Dairy Health Corporation as a test to monitor for DA. True positive rate and false positive rate at different FPR cut off levels (Geishauser et al. 1997a).

Table 1. Structure of a scenario to monitor dairy herds for displaced abomasum (DA) (Geishauser 1998).

A	B	C	D	E	F	G
2				Real	Predicted	
3					True	False
4	Herd Size	100	LDA Cases per Year	C4*C5	C4*C5*C9*C10	C4*(1-(C5*C6))*C11
5	LDA Incidence	0,02	LDA Loss per Year	C4*C5*C6	F4*C6	G4*C6
6	Loss per LDA ($)	250				
7						
8	Test Period (days)	30	Tests per Year	C4*C8*C12		
9	LDA% per Test Period	0,8	Test Costs per Year ($)	C4*C8*C12*C13		
10	True Positive Rate	0,6	Prevention ($) per Year	C14*(F4+G4)	C14*F4	C14*G4
11	False Positive Rate	0,3	LDA Loss per Year ($)	C6*(E4-F4)		
12	Tests per Test Period	0,14	Test+Prevention+Loss ($)	E9+E10+E11		
13	Costs per Test ($)	4				
14	Costs per Prevention ($)	50	Cost Effect Monitoring	F5-E12		

Table 2. Scenario A to monitor dairy herds for displaced abomasum (DA) (Geishauser 1998).

A	B	C	D	E	F	G
2				Real	Predicted	
3					True	False
4	Herd Size	100	LDA Cases per Year	2	1	30
5	LDA Incidence	0,02	LDA Loss per Year	500	240	7380
6	Loss per LDA ($)	250				
7						
8	Test Period (days)	30	Tests per Year	429		
9	LDA5 per Test Period	0,8	Test Costs per Year ($)	1714		
10	True Positive Rate	0,6	Prevention ($) per Year	1524	48	1476
11	False Positive Rate	0,3	LDA Loss per Year ($)	260		
12	Tests per Test Period	0,14	Test+PreventionLoss ($)	3498		
13	Costs per Test ($)	4				
14	Costs per Prevention ($)	50	Cost Effect Monitoring	-3258		

Table 3. Scenario B to monitor dariy herds for displaced abomasum (DA) (Geishauser 1998).

A	B	C	D	E	F	G
2				Real	Predicted	
3					True	False
4	Herd Size	100	LDA Cases per Year	20	13	25
5	LDA Incidence	0,2	LDA Loss per Year	8000	5120	10080
6	Loss per LDA($)	400				
7						
8	Test Period (days)	30	Tests per Year	429		
9	LDA% per Test Period	0,8	Test Costs per Year ($)	214		
10	True Positive Rate	0,8	Prevention ($) per Year	1900	640	1260
11	False Positive Rate	0,3	LDALoss per Year ($)		2880	
12	Tests per Test Period	0,14	Test+Prevention+Loss ($)	4994		
13	Costs per Test ($)	0,5				
14	Costs per Prevention ($)	50	Cost Effect Monitoring	126		

Future work may focus on the development of economical tests and effective preventive strategies.

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