Metabolic Disturbances in the Dairy Cow Influenced by Managerial Practices— Case Reports and Epidemiologic Studies

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A study was instituted at Dykstra Veterinary Hospital, Department of Surgery and Medicine, Kansas State University, to determine possible etiological denominators in high production dairy cows presented by owners with complaints of metabolic and/or infectious conditions commonly associated with high milk production. Subsequent field surveys of herds from which hospital patients originated were used to gain more information. The study spanned approximately five years with the departments of Surgery and Medicine, Pathology, Diagnostic Services, Clinical Pathology, Dairy Extension and practicing veterinarians cooperating.

Clients were primarily long-time dairymen whose cows exceeded average production. Common complaints included: 1) increased reproductive problems, 2) chronic, nonresponsive mastitis of varying etiology as to bacterial involvement, 3) poor response to clinically diagnosed hypocalcemic syndromes, 4) abomasal dilation and/or displacement, 5) prolonged parturition, 6) metritis and retained placentas, 7) decreased milk production, and 8) above average death losses usually immediately postpartum.

Common managerial and feeding programs were: 1) drylot confinement, 2) feeding high-yielding corn silage and/or haylage as roughage, 3) emphasis on "lead feeding", 4) emphasis on high concentrate/low fiber diet, and 5) emphasis on increased phosphorus intake via mineral supplements to prevent acute hypocalcemic cases. Almost all client and veterinary complaints came from herds that had been associated with such programs for at least two to three years.

The majority of the hospital cases were admitted with suspected abomasal disturbances. Physical examination and laparotomy, and clinical pathological surveys revealed high concurrent incidence of mastitis, metritis, serum calcium-phosphorus ratios altered to lower serum calcium levels, fatty livers, leukopenia, neutropenia, marginal anemia, and in extreme cases, thrombocytopenia.

Subsequent herd investigations revealed: 1) reproduction problems including repeat breeding and anovulatory estrus, 2) prolonged parturition, 3) retained placenta, 4) nonresponsive mastitis problems, 5) lowered milk production, 6) atypical, nonresponsive so-called hypocalcemic cases, 7) "downer cows" and 8) unusually high death losses following parturition. Most of the clients were satisfied with the general appearance and prepartum fleshing of the cows, although several were concerned about overconditioning.

The complaints could be classified into two categories: 1) the more chronic conditions, such as poor reproduction and associated utero-ovarian conditions, lowered milk production, and chronic mastitis, and 2) the more acute conditions such as abomasal dilations and/or displacements, so-called "fatty liver syndrome," and acute mastitis and metritis, all during the immediate postpartum period.

Client complaints generally came after the herds had been in confinement programs at least one year. There was general satisfaction with production and the decrease of acute hypocalcemia cases during the first year.

The first complaints in the affected herds appeared to deal with reproduction problems, usually first noted after the second parturition and after the common managerial and feeding program had been utilized for approximately one to one and one-half years.

Prominent necropsy lesions included: 1) mastitis, 2) atonic uteri and metritis, 3) enlarged, diffuse fatty liver, 4) atonic abomasum, 5) bone

marrow depression with lipid deposition, 6) osteoporosis and 7) pulmonary emphysema. Hemorrhage ranging from the ecchymotic type appearing primarily on the kidney to massive blood clots observed in the body cavities were observed in several cases.

A clinical pathological report of a hospitalized case of a severe nature is exemplified in Fig. 1. The cow was admitted to the hospital approximately one month following parturition. A left side abomasal displacement was diagnosed clinically.

Figure 1. Clinical Pathological Report

Case Number: 212,698
Subject: Holstein–Female–5 Years Old ("Flory")
Complaint: Possible Displaced Abomasum
Diagnosis: Left Side Displaced Abomasum

Laboratory Data:

Urea Nitrogen	12.2 mg%
Total Protein	.8.4 gm%
SG-OT	170 F.U.
Alk. P'tase	5.2 K.K.U.
Calcium	.8.4 mg%
Phosphorus	.6.7 mg%
Sodium	143 mEq/L
Potassium	3.5 mEq/L
Cloride	.87 mEq/L
Bicarbonate	31.4 mEq/L
Base Excess	+9.3 mEq/L
pH	7.530
Ketones	Trace
Magnesium	.3.33 mg%
PCV	.38.5 vol%
Hb	.12.0 gm%
WBC	.4,400 /cumm
Neut.	924 (21%)
Lymph.	3,124 (71%)
Mono.	308 (7%)
Eos.	44 (1%)
Platelets	133,000 /cumm
Prothrombin Time	12.5 seconds
Lee White Clotting Time	7'12"

Case Termination: Abomasopexy–Expiration After Six Days

The cow expired six days after hospitalization and after surgery apparently had successfully corrected the displaced abomasum. Necropsy lesions are listed in Fig. 2.

Figure 2. Necropsy Lesions.

Case Number: 212,698 ("Flory") (Con't)

Necropsy Lesions:

I. Outstanding Gross Lesions:
- A. Liver enlarged and extremely fatty
- B. Large clots of blood present in frontal sinuses
- C. Bisected long bones osteoporotic
- D. Excess muscle necrosis and edema

II. Histopathology Lesions:
- A. Fatty change in hepatic tissue and renal distal tubules
- B. Skeletal muscles revealed large swollen fibers
- C. Adrenal cortex hyperplastic
- D. Spleen had excess hemosiderin and lymphoid depletion
- E. Lymph nodes congested
- F. Bone marrow fatty–no hemopoietic foci observed.

In a subsequent herd survey, ten mid-lactation cows were selected as a random sample of the herd (Fig. 3). The data indicated an altered serum calcium/phosphorus ratio. The three cows with a reading of below 10 mg/% calcium had histories of reproductive problems.

Figure 3. Serum Calcium/Phosphorus Readings.

"Flory Herd Study"

Cow No.	Ca. /mg%	Phos. /mg%
1*	9.6	6.2
2	10.7	9.2
3	10.0	8.7
4*	9.4	6.95
5	10.0	8.55
6	10.6	6.85
7	10.6	8.5
8	10.1	6.8
9*	9.6	5.95
10	11.0	6.85
Average	10.16	7.48

*Cows had ovulatory problems.

A typical ration for another herd of 70 high producing Holstein cows prior to 1971 is listed in Fig. 4. The owner, concerned about high incidence of acute hypocalcemia, changed the ration to that listed in Fig. 5. He also changed the herd to dry-lot confinement.

Figure 4. Leadtka Herd Ration Prior to 1971.

Milo	8370 lbs.
Soybean (44% protein)	.1500
"Di-Cal" (26% Ca-20% Phos.)	50
Vitamins	15
Vit. A	4 million units
Vit. D	1 million units
Vit. E	500 units
Sodium Chloride	.65 lbs.
	10,000 lbs.

Corn Silage
Alfalfa Hay
Limited Brome Grass Pasture in summer

Figure 5. Leadtka Herd Ration Change–1971.

–Substituted Mono-Sodium Phosphate (0% Ca. - 22% Phos.) for "Di-Cal"

–Substituted Brome Hay for Alfalfa
- –Alfalfa (1.5% Ca - .24% Phos.)
- –Brome Hay (.4% Ca. - .25% Phos.)

The owner was very well satisfied with production and with decreased hypocalcemic cases and reproduction the first year. His complaints reached a climax early 1973 when the local veterinarian referred a cow to Dykstra Veterinary Hospital for diagnosis and treatment. The owner then had lost two cows with similar clinical syndromes. Data from the cow referred is listed in Fig. 6. Complete clinical pathological workup was lacking on this

Figure 6. Clinical Pathological Report.

Case Number:	211,694
Subject:	Holstein–Female–10 Years Old ("Leadtka")
Complaint:	Possible Left Side Displaced Abomasum
Diagnosis:	Left Side Displaced Abomasum

Laboratory Data:

Urea Nitrogen	16.3 mg%
Total Protein	4.9 gm%
SG-OT	190 F.U.
Calcium	
Phosphorus	
Sodium	134.5 mEq/L
Potassium	2.3 mEq/L
Chloride	79 mEq/L
Bicarbonate	38 mEq/L
Base Excess	+14 mEq/L
pH	7.520
PCO_2	47.0 mmHg
Ketones	Negative
Magnesium	
PCV	33 vol%
Hb	11.2 gm%
WBC	3,400 /cumm
Bands	136 (4%)
Neut.	1,325 (39%)
Lymph.	1,700 (50%)
Mono.	238 (7%)
Eos.	

Case Termination: Abomasopexy–Very slow hospital recovery–expired on farm three weeks following dismissal from hospital. No necropsy examination.

cow due to unavoidable circumstances; no serum calcium/phosphorus readings were made. An abomasopexy was performed, apparently successfully; however, the released cow expired in approximately three weeks. Due to an extreme distance between the client's farm and the hospital, a necropsy was not performed. Additional complaints from the client revealed approximately 80% incidence of nonresponsive mastitis, "downer cows," and reproduction problems.

A subsequent herd profile revealed a serum calcium/phosphorus ratio average of 1½ to 1 (Fig. 7). Necropsy on a similarly diseased cow from the same herd revealed the lesions indicated in Fig. 8. Herd hematology studies indicated an average leukocyte count of 7,162/cumm. in spite of the estimated 80% incidence of mastitis. Two cows had

Figure 7. Serum Calcium-Phosphorus Readings of Leadtka Herd. Random Sampling of Lactating Cows Prior to Instituting Therapeutic Ration.

Number of cows	8	
Calcium	8.6 to 11.3 mg%	Average 9.95 mg%
Phosphorus mg%	6.0 to 7.4 mg%	Average 6.7 mg%

Calcium-Phosphorus Ration = 1½ to 1

Note: Normal ranges:

Calcium	10.5 - 11.1 mg%
Phosphorus	4.0 - 7.4 mg%

Figure 8. Necropsy Report on Leadtka Cow.

Case Number:	Necropsy No. 73-650–D.O.A. ("Leadtka")
Subject:	Holstein–Female–6 Years Old
Complaint:	Metabolic Disturbance; Mastitis
Diagnosis:	"Fatty Liver Syndrome"; Mastitis

Necropsy Lesions:

1. Outstanding Gross Lesions
   - A. Greatly enlarged diffuse fatty liver
   - B. Bone marrow depletion of femur
   - C. Marked interlobular emphysema of lungs
   - D. Abscessation of mammary gland
   - E. Purulent mastitis
   - F. Ulceration of abomasum
   - G. Chronic infarcts of kidney

leukocyte counts below 3,700/cumm; both later expired. One was diagnosed in the field as acute mastitis and the other as left side abomasal displacement.

The ration now has been changed to that listed in Fig. 9; intensive mastitis control measures were instituted, and dry cows were separated so their energy intake during the dry period is less than that of lactating cows. As with other similar herds, approximately six months was required to bring the herd back in a reasonably normal health and production. Acute hypocalcemia cases did increase, but they responded to normal calcium therapy.

Figure 9. Leadtka Herd Ration Change–1973 (Therapeutic). (4-25-73)

Corn	10,420 lbs.
Concentrate (38% prot.)	1,800
Steamed Bone Meal (30% Ca.-14% Phos.)	120
Ground Limestone (33% Ca.-0% Phos.)	60
Vitamins	U.S.P.
Vit. A	20,000 Units/lb*
Vit. D_3	5,000 U.S.P. Units/lb.*
Trace Minerals	60
	12,450 lbs.

*Vitamin supplement included in "Concentrate" (U.S.P. Units/lb.)

Data concerning 15 cows from herds with similar histories admitted to Dykstra Veterinary Hospital are shown in Figs. 10-14. Four of these cows underwent karyotyping. Cultures of peripheral blood revealed between 11.9 to 18.6 percent polyploid cells in culture in contrast to controls which had about 0.5 percent polyploid karyotypes.

It is our opinion that the clinical cases with marked neutropenia along with the altered calcium/phosphorus ratio do not respond to either medicinal or surgical treatment in a satisfactory manner.

Data now accummulated suggest that common managerial and/or feeding practices of the affected herds have apparently affected normal calcium metabolism. Smooth muscle atony appears to be a prominent common denominator. The organs

Figure 10. Clinical and Laboratory Data on 15 Representative Cows from Different Herds.

Case No.	Age	Breed	Sex	Clinical Diagnosis	Post-Partum Days
214,201	5 yr.	Holstein	F	L.D.A. Fatty Liver Syndrome	7 days
214,259	5 yr.	Holstein	F	L.D.A. Fatty Liver Syndrome	30 days
214,200	4 yr.	Holstein	F	L.D.A. Fatty Liver Syndrome	7 days
214,258	5 yr.	Holstein	F	Fatty Liver Syndrome	28 days
214,257	5 yr.	Holstein	F	Fatty Liver Syndrome	30 days
214,146	4 yr.	Holstein	F	Fatty Liver Syndrome	8 days
213,562	5 yr.	Holstein	F	L.D.A. Fatty Liver Syndrome	30 days
214,394	4 yr.	Holstein	F	R.D.A. Liver Abscesses	40 days
214,659	3½ yr.	Holstein	F	R.D.A. Metritis	21 days
206,590	9 yr.	Holstein	F	L.D.A. Metritis	11 days
212,635	6 yr.	Holstein	F	L.D.A.	60 days
212,698	5 yr.	Holstein	F	L.D.A. Fatty Liver Syndrome	23 days
211,996	9 yr.	Holstein	F	R.D.A.	21 days
212,576	5 yr.	Holstein	F	L.D.A. Mastitis	21 days
211,965	4 yr.	Holstein	F	L.D.A. Fatty Liver Syndrome	21 days
Average	5.23 yr.				23.87 days

commonly affected and the relationship of smooth muscle is indicated in Fig. 15.

Figure 15: Smooth Muscle Constituents of Specific Bovine Organs.

OVARY - Hilus musculature (contraction stimulates ovulation)
UTERUS - myometrium
ABOMASUM – longitudinal and circular layers
UDDER - myoepithelial cells–responsible for squeezing milk from the alveoli

The problem appears to be a complicated interrelated metabolic syndrome that influences several disease entities. The role of hormones, exercise, hypo- and hyperthermic stress, parturition, high energy feedstuffs all have to be considered.

It is our feeling that long term predisposing factors involving limited calcium intake is the common denominator that predisposes to acute syndromes involving bacterial infections and marked metabolic disturbances.

Figure 11. Clinical and Laboratory Data on 15 Representative Cows from Different Herds.

Ca.	Serum P.	Mg.	SG-OT	Ketone	Alk. P'tase	B.U.N.
11.1 /mg%	5.6-6.5 mg%	1.8-2.3 mg%	100-150 F.U.		6 K.K.	10-20 mg%
7.0	4.7	2.78	340	Neg.	4.55	8.2
9.3	3.1	2.43	195	Neg	2.5	7.8
7.3	5.3	3.24	928	Neg.	4.90	10.8
8.5	7.6	2.76	140	Neg.	3.7	7.8
8.6	3.4	2.71	172	Neg.	6.2	8.6
9.6	3.7	3.01	560	Neg.	6.2	13.6
8.7	4.3	2.71	125	Neg.	5.5	9.8
7.0	4.8	2.93	140	Neg.	11.	25.
7.8	8.8	2.90	530	Neg.	10.5	23.3
7.0	3.6	2.36	465	Trace	3.7	7.25
7.1	5.8	2.64	180	Neg.	2.5	7.8
8.4	6.7	3.33	170	Trace	3.33	5.9
7.5	5.55	2.60	130	Neg.	5.0	23.2
8.6	4.85	2.74	315	--	4.0	14.9
8.24	8.3	3.28	290	--	4.0	22.3
Avg. 8.04	5.36	2.83	312		5.17	13.09

Figure 12. Blood Chemistry: Clinical and Laboratory Data on 15 Representative Cows from Different Herds.

Total Protein	Na.	K.	Chloride	Bicarbonate	Base Excess	pH	PCO_2
7.56 mg%	142 mEq/L	4.8 mEq/L	104 mEq/L	25-31 mEq/L	+3 mEq/L	7.35-7.45	35-34 mEq/L
5.5	145	3.2	145	33	+ 9	7.49	43.5
8.2	137	4.1	99	27	+ 3	7.47	42.5
5.9	143	3.9	98	27.5	+ 3	7.42	44
6.7	146	4.3	103	26	+ 3	7.45	38.5
6.7	145	4.2	100	25.5	+ 3	7.465	36.5
7.3	138.5	3.9	92	33	+ 9	7.5	42
7.8	140	3.8	100	32.5	+ 8	7.45	48
7.8	160	3.2	90	33	+ 9	7.53	41.5
7.6	142	2.2	85	37	+12	7.5	49
6.3	142	3.65	100	28	+ 3	7.44	40
7.4	140.5	4.1	98	24	- 0.7	7.383	41.3
8.4	143	3.5	87	31.4	+ 9.3	7.53	
6.4	135.5	4.4	107	46	+19	7.395	77
5.5	136	3.5	87	31.5	+ 8.5	7.84	43.2
	148.5	3.8	93	34	+ 5	7.40	55
Average 6.96	142.8	3.72	98.93	31.29		7.48	42.85

Figure 13. Clinical and Laboratory Data on 15 Representative Cows From Different Herds.

Fibrinogen	P.C.V.	Hb.	W.B.C.	Bands	Neut.	Lymph.	Mono.	Eso.	Bas.
200-800 mg%	35 vol%	11.5 gm%	8,000 /cumm		28-30% /cumm	58% /cumm	4% /cumm	9% /cumm	0-1% /cumm
600	29	9.7	4,000		8	88	3	1	
500	29.5	9.9	10,800		52	34	6	6	
700	39	13.3	6,000		27	60	2	3	
1400	31	10.8	12,700		52	41	6	1	
400	33.5	10.8	23,100	3	80	14	3		
400	39	13	6,500	1	43	44	10	2	
300	31	10.8	10,600	1	40	37	5	17	
1000	37	12.5	16,700	25	49	20	6		
400	40	13.8	12,400	29	33	30	8		
	30	10.2	2,900	2	14	70	14		
	23.5	8	4,100		33	57	9		1
	33.5	10.9	3,300		25	69	3	3	
	25	8.7	6,900	1	64	29	6		
	32	10.9	2,200		42	55	3		
	37	12.3	2,400	2	22	73	3		
633	32.7	11.04	8,306		43.2	48.07	5.8	2.2	

Figure 14. Clinical and Laboratory Data on 15 Representative Cows from Different Herds.

Platelets	Clinical Response – Other Observations
300,000 – 800,000/cumm	
728,000	Abomasopexy - Expired
630,000	Abomasopexy - Recovered
714,000	Abomasopexy - Recovered
620,000	Medication - Recovered
353,000	Medication - Recovered
505,000	Medication - Recovered
660,000	Abomasopexy - Recovered
956,000	Medication - Recovered
789,000	Abomasopexy - Recovered
	Abomasopexy - Slow Hospital Recovery–Expired Later
	Abomasopexy - Slow Recovery
	Abomasopexy - Expired
	Abomasopexy - Recovered
	Abomasopexy - Expired
	Abomasopexy - Slow Recovery
661,670 Average	

Notice

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Practice Tips...

To relieve a hip-lock dystocia, affix a calf-puller with very little tension, grasp the distal end of the bar, and pull the bar downward in an arc directed between the cow's hind legs (easiest when cow is down).

Fred Conkel, *D.V.M.*, Grants Pass, Oregon

For severe footrot cases, especially during damp periods, I clean thoroughly between the digits and then I place a large piece of cotton saturated in either Sulfapyridine or Furacin solution between the digits. The entire hoof and interdigital space is then wrapped in a figure 8 method with 4" plaster of paris bandage. This is left on usually until it falls off in about a month, as a rule, or is removed then. I caution the owner to watch for swelling, but this has never been a problem.

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