Case Report Rapport de cas

An outbreak of sand impaction in postpartum dairy cows

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Abstract — Twenty-two cases of indigestion occurred in a 650-cow herd. Five cows had severe sand abomasal impaction, diagnosed by laparotomy. The pH of prepartum cows' urine was < 6.0 and of sand 8.0. Feed showed a dietary cation-anion difference ≤ -110 mEq/kg. After feeding management corrections, no more cases were diagnosed.

Résumé — Une irruption d'impaction de sable chez des vaches laitières après la mise bas. Vingt-deux cas d'indigestion se sont produits dans un troupeau de 650 vaches. Cinq vaches ont eu une grave impaction de l'abomasum par du sable diagnostiquée par laparotomie. Le pH de l'urine des vaches avant la mise bas était de < 6,0. Le sable avait un pH de 8,0. Le taux de DCAD dans la nourriture était de ≤ -110 mEq/kg. Après correction de la gestion de l'alimentation, aucun cas d'indigestion n'a été diagnostiqué.

(Traduit par les auteurs)

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Five severe cases of sand impaction occurred at the Dairy Research Unit, University of Florida (U of F). The unit is located northwest of Gainesville, Florida (29.6° north, 82.2° west) and has a typical subtropical climate.

The herd consisted of 500 milking cows. Lactating cows were milked and fed 3 times a day. Diet was fed as a total mixed ration (TMR) to meet or exceed National Research Council (NRC) recommendations (1–3) and comprised corn silage, alfalfa hay, and concentrates (Table 1). Cows were housed in a free-stall system with sand bedding, and head-locks on the feed-bunk area. Rolling herd average was 9500 kg of milk per cow per year.

Cows were dried-off in a base routine and moved to a far-off dry lot until 30 d before expected parturition (BEP) (prepartum transition dry lot). At 7 d BEP they were moved to a maternity barn equipped with fans (tunnel ventilation) and sand bedding. They remained in this barn until 6 h postpartum. Transition prepartum cows received anionic salts in their TMR diet as a preventive measure for clinical hypocalcemia and its related disorders (1–3). Urine pH of cows in the maternity barn was evaluated weekly by the food animal service of U of F.

Case description

During the veterinary visit the week of July 4, 2005, an increase in the occurrence of periparturient disorders (retained fetal membranes, metritis, diarrhea, off-feed, ketonuria, constipation) was established (4). The herd average milk production had decreased from 32 kg/d/cow to less than 28 kg/d/cow. Samples for urine pH analysis were obtained from 20% of the immediate prepartum cows (maternity barn); the results were consistently low with a range of 5.2 to 6.2. Body condition scores (scale 1 to 5; 1/4 point change) were slightly higher than normal (3.5), with a median value of 3.75 and a range of 3.0–4.0.

On July 11, 2005, the urine pH was less variable but more acidic, with a range of 5.0 to 5.7. A feed sample was taken from the maternity barn and submitted for nutritional analysis (Dairy One Forage Laboratory, Ithaca, New York, USA). Energy and protein levels were within normal ranges. However, major minerals used to determine the dietary cation anionic difference (DCAD), based on the equation (Na + K) - (Cl + S), showed that the difference was -119 mEq/kg on a dry matter (DM) basis, which is a value exceeding the recommended amount of milliequivalents (no > -100 mEq/kg DM) for prepartum transition cows (2,3) (Table 1). Adjustments of the ration were made to solve the problem of over-acidification of transition cows. The occurrence of postpartum cases was still high and the animals were treated conservatively with mineral oil (2 L), magnesium hydroxide (27 g), and oral fluids (25 L of water) plus calcium propionate (510 g). On August 24, 2005, the first case of sand abomasal impaction (5) was diagnosed by laparotomy (Table 2). Subsequently, during a farm visit on August 25, 2005, urine pH of all sampled cows was still extremely acidic (5.2 to 5.9). In addition, the frequency rate of occurrence of postpartum conditions had not decreased during the last 3 wk, with poor prognosis for 7 cases (2 left displacements of the abomasum, 1 cecum distention, 4 rumen indigestions with low intestinal transit). On August 31, the 2nd case was diagnosed (Table 2). The cow presented constipation and was treated with mineral oil (2 L) and 3 oral boluses of magnesium hydroxide (27 g). An exploratory laparotomy was performed. Supportive therapy was continued for the next 3 d and systemic penicillin was also administered (10 000 IU/kg/d for 7 d). The cow died soon after

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Table 1. Nutrient content prepartum total mixed ration sampled at different dates

Nutrient	Date of sampling (m/d/y)					
	04/25/05	07/11/05	08/31/05	09/19/05	10/20/05	Range[a]
Dry matter (%)	50.1	48.2	45.6	58.7	57.5	45–60
Crude protein (%)	13.6	15.4	15.5	14.1	13.0	12–13
Acid detergent fiber (%)	22.9	26.8	29.1	29	32.6	17–21
Neutral detergent fiber (%)	38.3	42.4	45.3	45.4	47.8	25–33
Net energy lac. (Mcal/kg)	1.63	1.58	1.54	1.58	1.56	1.54–1.62
Calcium (Ca) %	1.54	1.29	1.22	1.12	0.78	0.6–1.5
Phosphorus (P) %	0.35	0.32	0.32	0.31	0.33	0.35–0.40
Potassium (K) %	1.3	1.16	1.2	1.27	1.16	0.52–1.3
Magnesium (Mg) %	0.34	0.32	0.32	0.30	0.30	0.35–0.4
Sodium (Na)%	0.50	0.23	0.50	0.71	0.22	0.1–0.16
Sulfur (S) %	0.25	0.31	0.29	0.29	0.25	0.3–0.4
Chloride (Cl) %	1.81	1.13	1.70	2.04	0.89	0.8–1.2
Dietary cation anion Difference (mEq/kg)[b]	-87.7	-119.4	-135.6	-122.3	-14.3	-75 to 0

[a] Range of nutritional recommendations based on National Research Council reommendation (3)
[b] Based on the equation (Na + K) – (Cl + S)

the surgery. During the necropsy, abomasal sand impaction was confirmed. A second feed sample was taken on August 31, 2005, and the DCAD was -135.6 mEq/kg DM, which was consistent with the values of low urine pH (< 6.0) (Table 1). On September 07, 2005, the 3rd case was diagnosed (Table 2). On September 12, 2005, a similar case was presented (Table 2). On September 16, 2005, the last case was described (Table 2). On September 19, 2005 a third feed sample was taken and the DCAD was again low (-122.3 mEq/kg DM) (Table 1). At that point, a more aggressive approach was established. Anionic salts were decreased drastically. Although the theoretical DCAD was within the expected values, the 3 feed samples taken between July and September (Table 1) showed the opposite. Efforts were made to be consistent, but the results of urine pH analysis of subsequent visits were still inconsistent. A water sample from the maternity barn and a sand sample from a new batch of sand were obtained for chemical analysis. The results of water analysis provided no significant findings.

The sand was changed to a purer silicate from a different supplier. In addition, for financial constrains, the amount of sand used as bedding was decreased and combined with sawdust for the maternity barn. Furthermore, a sample of anionic salts was submitted for mineral analysis. Results demonstrated that the chloride content (12%) was higher than the expected value (9%). The feeding program, including anionic salts, was readjusted and managed differently according to guidelines established by a new standard operating program. After these changes, a feed sample was analyzed on October 15 (Table 1). Results demonstrated that the chloride content was reduced and the DCAD was -14.3 mEq/kg DM. Urine pH's were at this point less acidic (6.5 to 7.5). From October 1 until November 30, 2005, no more cases of sand impaction were reported or diagnosed, and the occurrence of postpartum conditions decreased.

Discussion

The hypothesis of this case was that because cows had a urine pH below 6.0 they might have been suffering a mild stage of metabolic acidosis and were consuming sand (that was alkaline) either to buffer the body or because of aberrant behavior due perhaps to acid-base balance disturbance. Acidic urine in ruminants implies a large excretion of H^+ by the kidneys. Whether this excretion has adequately maintained the blood pH and bicarbonate concentrations cannot be ascertained by urine pH measurement alone; therefore, blood pH or blood gas analysis should be considered. If sand is pure silicate, the pH should be 7.0. In addition, soils from the southeast part of the USA tend to be more acidic than soils from the west. Unexpectedly, the sand pH of the sample was 8.0. The composition of the sand was 65% of silicate, approximately 20% of clay, and 15% of lime. The sand had been obtained from a new supplier 4 mo ago, was different from that used historically by the farm, and came from excavations (2 m deep) in a field in which liming (calcium carbonate application) had been a common practice during earlier years.

The definition of "outbreak" in epidemiologic terms is an increase in the number of cases over a normal expected value during a period of time (4). Between July and September 2005, there were 134 calvings and 22 (16.4%) cases of postpartum disorders within the first 30 DIM, 5 of which cases (22.7%) were abomasal sand impaction, diagnosed by laparotomy. These values were extremely high, and since no similar cases had been diagnosed previously, they fit the definition of an outbreak. In a recent retrospective case analysis from animals received at the Veterinary Teaching Hospital, University of Illinois, abomasal impaction was diagnosed in only 1.3% of cases (80/6204) admitted to the hospital between 1980 and 2003. This value is considerably lower than the value of 22.7% (5/22) reported by the present study.

One of the preventive measures for hypocalcemia is the use of anionic salts during the immediate prepartum period (1,2). The rationale behind this method is that anionic salts induce a mild acidification of the body in which the activity of PTH, and vitamin D_3 collectively enhance calcium homeostasis (1). Goff et al (6) demonstrated that cows receiving 2.25 Eq of chloride had lower urine pH and lower blood pH than cows receiving either sulfate or water. The evaluation of urine pH of prepartum cows once a week is recommended as a safe, quick, and inexpensive

Table 2. Summary of clinical findings in 5 cases of severe abomasal sand impaction

Cow Number	# 6255	#5029	# 5136	#3739	#5106
Date of presentation (m/d/y)	08/24/05	08/31/05	09/07/05	09/12/05	09/16/05
Lactation	1	1	2	3	1
Days in milk	14	29	12	22	13
Rumen contractions	0	0	0	0	0
Rectal palpation	Scanty feces	Scanty feces	Scanty feces	Scanty feces	Scanty feces
Milk yield decrease	20 kg	20 kg	25 kg	18 kg	20 kg
Other[a]	Ping left side	No ping sound	Ping left side	Ping left side	No ping sound
Exploratory surgical findings	Sand in abomasum, 25 kg removed	Large amount of sand in abomasum	Large amount of sand in abomasum	Sand in abomasum, 25 kg removed	Large amount of sand in reticulum and abomasum
Final result	Euthanasia	Died	Died[b]	Euthanasia	Died[b]
Necropsy findings	Abomasistis, abomasal ulcers, hepatic lipidosis	Sand in abomasum, abomasitis	No necropsy was conducted	Hemorrhagic, acute and extensive abomasitis	Fibrinous, diffuse, acute, and severe peritonitis and hemorrhagic, acute and extensive abomasitis

[a] Simultaneous percussion and auscultation of left paralumbar fossa
[b] Death occurred within 10 d after surgery

method to monitor the correct feeding of anionic salts in dairy herds (2,6). Normal urine pH of cows fed traditional nonanionic diets is alkaline (pH: 8.0–8.5). A target for Holstein cows fed anionic salts should be an acid urine, with a pH between 6.0 and 6.8. Lower urine pH (< 6.0), due to an overfeeding of anionic salts or an inadequate management of the anionic diet, might compromise the normal acid-base balance of the body, placing the animals at risk for a noncompensated metabolic acidosis (2,7,8); therefore, the use of anionic salts must be consistent and adequately monitored (1). Indeed, in a recent meta-analysis publication (2), the authors concluded that decreasing the DCAD close to 0, with a mean urinary pH of 7.0, reduced the risk for clinical milk fever drastically. Acidification beyond urinary pH of about 7.0 could further decrease DMI without much additional benefit toward milk fever prevention. Urine pHs from July 04, 2005 to September 29, 2005, were consistently lower than expected (6.0–6.8) and likely physiologically dangerous (2,8). Coincidentally, when urine pHs improved, with values higher than those reported before the outbreak (pH < 6.0) and the amount of sand was decreased and purchased from a different supplier, the cases of sand impaction ceased. Although a cause-effect association cannot be established between the mild metabolic acidosis and the consumption of alkaline sand as a potential buffer, it can be suggested that the cases of sand impaction stopped because of the improvement in the anionic diet program and sand management. Several farms in Florida use sand for bedding. Historically, minimal amounts of sand have commonly been found in the digestive tract of cows when laparotomies or digestive surgeries were performed. However, similar cases to those reported in this study have not been diagnosed by the Food Animal Group, U of F, after analyzing records of digestive surgeries for more than 15 years of service.

The 2 cases that resulted in death and were necropsied at the VMC, U of F (cows #6255 and #5106) were extremely severe cases of sand impaction. At least, 25 kg of sand was removed from the prestomachs in each animal. In 1 of the cases, the abomasum felt like a rock externally, and in the other case, the reticulum stones could be felt inside the organ. These findings unquestionably explained the constipation and many of the other signs diagnosed during the outbreak. None of the clinical signs in the cases reported were typical of displacement or volvulus of the abomasum. Major signs were depression, inactive rumen and bloat, decreased to no fecal transit, colic pain, but no typical "ping" sound. In addition, all the cases had to be diagnosed on laparotomy, as in previous reports (9–11).

Regarding the anionic diet program and the consumption of alkaline sand, it is reasonable to suggest that the excessive use of anionic salts, which may have induced a non-physiological metabolic acidosis (confirmed by the urine pHs), might have been a key factor in the consumption of a large amount of sand. In support of this suggestion is the fact that all cases occurred within the first 20 d postpartum, implying that the origin of the problem took place during the transition period and perhaps within a week pre- and postpartum. Abomasal impactions are usually of gradual onset (10,11).

Since the high pH of the sand was due to its content of calcium carbonate (limestone, 15%), we propose that the sand was consumed either to potentially buffer the imbalance of acid-base equilibrium or because of aberrant behavior. In fact, in a study conducted on Holstein cows, a TMR containing buffers resulted in a higher consumption and a higher urine pH than did forages and concentrate fed separately without buffers and without causing mild rumen acidosis (12). In addition, when rats, cats, sheep, and cows experienced either metabolic or rumen acidosis, it altered their normal behavior by causing them to eat less feed and have increased anxiety, or by affecting their feed selection (2,13–17). These behavioral changes were experienced either because of neurological alterations induced by the acidemia (15,17) or to compensate the acid-base unbalance of the body

and rumen (13,14,16). Calcium carbonate is poorly absorbed in cattle and does not significantly affect acid-base equilibrium or urine pH (18,19), which could explain why sand consumption was excessive.

Abomasal impaction due to sand consumption has rarely been reported. Indeed, in the report of Wittek et al (5) on 80 cases of abomasal impaction, no cases of sand impaction were described. Sand impaction was reported in 1973 in a herd of beef cattle in which affected cattle had low body condition scores, were fed an insufficient quantity of hay, and started to consume excessive amounts of sand after the hay had been consumed (20). Another case of gravel impaction was reported in 2 cows admitted to the veterinary teaching hospital at the Colorado State University from dry-lot dairies. The authors proposed that these cows were prone to ingest sand and stones with their feed (scraped from bunker silos) or as a result of "pica" (depraved appetite) (21). Neither of the previous reports fits with the descriptions of the present report, where cows were fed a theoretically balanced TMR. CVJ

References

1. Goff JP, Horst RL. Physiological changes at parturition and their relationship to metabolic disorders. J Dairy Sci 1997;80:1260–1268.
2. Charbonneau E, Pellerin D, Oetzel GR. Impact of lowering dietary cation-anion difference in nonlactating dairy cows: a meta analysis. J Dairy Sci 2006;89:537–548.
3. National Research Council. Nutrient requirements of dairy cattle. 7th revised ed. Washington, DC: Nat Acad Pr, 2001:184–213.
4. Dohoo I, Martin W, Stryhn H. Veterinary Epidemiologic Research. Charlottetown, Prince Edward Island: AVC Inc, 2003:75.
5. Wittek T, Constable PD, Morin DE. Abomasal impaction in Holstein-Friesian cows: 80 cases (1980–2003). J Am Vet Med Assoc 2005;227: 287–291.
6. Goff JP, Ruiz R, Horst RL. Relative acidifying activity of anionic salts commonly used to prevent milk fever. J Dairy Sci 2004;87: 1245–1255.
7. Oetzel GR, Fettman MJ, Hamar DW, Olson JD. Screening of anionic salts for palatability, effects on acid-base status, and urinary calcium excretion in dairy cows. J Dairy Sci 1991;74:965–971.
8. Vagnoni DB, Oetzel GR. Effects of dietary cation-anion difference on the acid-base status of dry cows. J Dairy Sci 1998;81:1643–1652.
9. Merritt AM, Boucher WB. Surgical treatment of abomasal impaction in the cow. J Am Vet Med Assoc 1967;150:1115–1120.
10. Baker JS. Abomasal impaction and related obstructions of the forestomachs in cattle. J Am Vet Med Assoc 1979;175:1250–1253.
11. Mitchell KJ. Dietary abomasal impaction in a herd of dairy replacement heifers. J Am Vet Med Assoc 1991;198:1408–1409.
12. West JW, Coppock CE, Nave DH, Schelling GT. Effects of potassium buffers on feed intake in lactating dairy cows and on rumen fermentation in vivo and in vitro. J Dairy Sci 1986;69:124–134.
13. Cook NE, Rogers QR, Morris JG. Acid-base balance affects dietary choice in cats. Appetite 1996;26:175–192.
14. Phy TS, Provenza FD. Sheep fed grain prefer foods and solutions that attenuate acidosis. J Anim Sci 1998;76:954–960.
15. Brusque AM, Mello CF, Buchanan DN, et al. Effect of chemically induced propionic academia on neurobehavioral development of rats. Pharmacol Biochem Behav 1999;64:529–534.
16. Keunen JE, Plaizier JC, Kyriazakis L, et al. Effects of a subacute ruminal acidosis model on the diet selection of dairy cows. J Dairy Sci 2002;85:3304–3313.
17. Hanstock TL, Clayton EH, Li KM, Mallet PE. Anxiety and aggression associated with the fermentation of carbohydrates in the hindgut of rats. Physiol Behav 2004;82:357–368.
18. Goff JP, Horst RL. Oral administration of calcium salts for treatment of hypocalcemia in cattle. J Dairy Sci 1993;76:101–108.
19. Classen HG, Schutte K, Schimatschek HF. Different effects of three high-dose oral calcium salts on acid-base metabolism, plasma electrolytes and urine parameters of rats. Methods Find Exp Clin Pharmacol 1995;17:437–442.
20. Hunter R. Sand impaction in a herd of beef cattle. J Am Vet Med Assoc 1975;166:1179.
21. Cebra C, Cebra M, Garry F. Gravel obstruction in the abomasum or duodenum of two cows. J Am Vet Med Assoc 1996;209:1294–1296.