Force-Feeding And Rumen Acidosis In Young Calves

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In a preceding paper (5) it was shown that 'ruminal drinking' due to dysfunction of the oesophageal groove can have severe consequences not only in initially healthy veal calves, as demonstrated by Dutch investigators (1,12,14), but also in new-born dairy calves suffering from various primary diseases. If milk, milk replacer or corresponding nutrient liquids remain in the reticulo-rumen for a sufficient period of time, the nutrients they contain, in particular easily digestible carbohydrates, are subjected to bacterial breakdown. The resulting products are mainly fatty acids and/or lactic acid, so that the pH-value of the liquid ruminal content drops to pH 5 to 4. In that case the disorder can be termed as 'rumen acidosis'.

According to the results of several investigations into the function of the oesophageal groove in healthy calves, it can be calculated that, on average, less than 10% of the consumed milk/fluid escapes into the reticulo-rumen (5,7). Under certain circumstances, however, even in healthy calves the outflow can be much higher, and in sick calves with manifest disorder of the oesophageal groove, up to 100% of the consumed milk can be found in the rumen (1,7,14).

If force-feeding is practiced, either by stomach tube or by a so-called oesophageal feeder, the whole volume usually flows into the reticulo-ruminal cavity; the same may occur when a sick calf is force-fed via a teat bottle.

From X-ray examinations (2,9 and others) and endoscopic observations (3) it can be concluded that liquid feed entering the reticulo-rumen of healthy young calves is transferred to the omasum and abomasum by active transportation. Furthermore, the experiments of CHAPMAN *et al.* (2) support the assumption that passive overflow of ruminal fluid to the abomasum can also take place, provided the quantity is large enough (administration of at least 2 1). LATEUR-ROWET and BREUKINK (9) have shown that in normal calves most of the milk entering the reticulo-rumen leaves these forestomachs within three hours.

In the majority of the young calves, in healthy ones as well as in sick ones, the liquid feed obviously passes the reticulo-rumen without detrimental effects on the organ or the animal. On the other hand, however, it may cause ruminal and metabolic acidosis and rumenitis if it enters the reticulo-rumen repeatedly in large quantities and/or if the flow is delayed. This paper describes the findings in 23 young calves hospitalized in 1989 for various reasons with a history of having been force-fed prior to their presentation at the clinic.

Materials and Methods

The 23 calves included in this evaluation were selected on the basis of the anamnesis given by the owner, indicating that the patient had to be force-fed repeatedly. The anamnestic data were collected at an interview with the owner when the calf was brought to the clinic.

On the day of hospitalization, the patient was examined clinically, including the rumen and the rumen fluid examinations as described in the preceding paper (5), and blood samples were taken for routine examinations in the laboratory. The clinical examination was repeated daily during the hospitalization period. Rumen fluid and blood examinations were performed when they seemed indicated. Calves which had to be euthanatized or died were necropsied and the changes were documented.

Results

Breed, age and sex distribution: All calves were Simmentals (Deutsches Fleckvieh); 22 of them were within the age group up to 14 days, one was older; 12 were female, 11 were male.

Reasons for hospitalization: The calves were presented to the clinic for the following reasons:

neonatal diarrhea:		11 calves
Unable, too weak or listless to suck		12 calves
since birth	8	
later	4	

Liquid feeds used; frequency and length of force-feeding (Fig 1): The liquid feedstuffs used are listed in table 1. Of 18 calves on which data on the frequency of force-feeding were available, 3 were fed two times, 12 three times and 3 five times per day. Exact data on the length of the preceding force-feeding period could be obtained for 19 animals. The average time was 4 days, with a variation from 1 to 10 days.

Rumen fluid findings: Rumen fluid could be obtained easily with the instrument described previously (4). Of the 23 samples, taken at hospitalization, 20 had to be aspirated while on three occasions the ruminal liquid flowed out spontaneously when the suction head was introduced into the rumen. In total, 52 rumen fluid samples were taken

Table 1: Type of liquid feeds used in 23 force-fed calves.

Group	Type of liquid feed	Number of Animals
1	cow's milk	12
2	nutrient-electrolyte solutions	5
3	cow milk as well as nutrient-electrolyte solutions	3
4	cowmilk as well as so-called 'diet drinks' (gruel, cocoa, and others)	3

from these patients during the observation period and seven times a spontaneous outflow could be observed = 16% of the total number of samples. The results of the first rumen fluid examination are indicated in table 2. Table 3 shows the distribution of the force-fed calves in relation to the pH of the rumen fluid sample and the type of liquid feed.

On the basis of pH-value and gross findings, 20 of the 23 samples were considered indicative for *acidosis* and 3 for *putrefaction.*

Table 2: Gross findings, pH-value and results of the centrifugation test of rumen fluid samples, taken at hospitalization, from 23 force-fed calves.

pH-Value	Color	Smell	Viscosity	Centrifugation Test
3.8-5.5	milky 4	sour 10	watery 3	+ 9
n=14	beige 5	rancid 1	creamy 5	not
	grey 5	stale 3	pasty 6	ex. 5
5.6 - 6.5	milky 4	sour 6	watery 1	+6
n = 9	brown 2	stale /3	creamy 4	not
	grey 3	putrid	pasty 1	ex. 5
			not ex. 3	

Table 3: Distribution of 23 force-fed calves in relation to the pH of the rumen fluid sample and the type of liquid feed.

pH Value	Milk (n)	NES (n)	Milk + NES (n)	Milk + 'Diet Drinks' (n)
3.8-5.5	7	4	1	2
5.6-6.5	5	1	2	1

NES = nutrient-electrolyte solution

Blood acid-base status at hospitalization: In 12 of the 23 force-fed patients, blood base excess (BE) was in the negative range (Figure 2). The distribution was as follows:

slight acidosis	= BE	±0 to -10	4 calves
moderatc acidosis	= BE	-10 to -20	6 calves
severe acidosis	= BE	-20	2 calves

In relation to feeding groups listed in table 1 the distribution of the acidotic calves was:

Group	1	2	3	4
Number	8	6	4	4

Of the 12 acidotic calves 7 were suffering from diarrhea.

Treatment

The treatment depends on the primary disease, the general status of the animal, changes in the ruminal fluid as well as on the expected degree of rumenitis. If force-feeding has already been practiced for a relatively long period of time and the ruminal fluid examination indicates a marked acidosis, severe changes of the ruminal mucosa can be expected (Figure 3). In those cases, frequently all therapeutical efforts are in vain.

In order to improve the general status of the animal, which is the first prerequisite so that the calf is able to drink by itself, in acidotic patients an adequate parenternal rehydration and acidosis therapy is necessary and is the first step of the treatment.

The next step is to perform a rumen lavage. After as much of the acidic rumen fluid as possible is siphoned off, lukewarm water is infused and siphoned off again. This has to be performed one to three times until the fluid shows a water-like appearance, while retaining, of course, a turbid transparency. Rumen lavage is done once a day and is repeated, if necessary, on the successive days.

In some recent cases 1 g chlortetracycline was administered intraruminally after rumen lavage to inhibit further fermentation processes. However, the efficacy of that measure has still to be clarified.

Simultaneously, appetite, sucking reflex and function of the oesophageal groove should be stimulated by the following measures:

- careful handling of the animal and training it to suck on a nipple,
- the daily milk ration should be offered in three to four portions; the calf should suck on an (empty) nipple prior to milk feeding,
- injection of Brotizolam (Mederantil^{R}-Boehringer, Ingelheim) 0.2 mg/100 kg b.w. before offering the milk, and that in particular in calves which refuse to drink at all (6).

If Brotizolam has no effect on milk intake, intravenous injection of 0.08 IU Vasopressin per kg b.w. can be tried, to induce closure of the oesophageal groove before the milk is offered (11).

If all the measures fail, one should try to change the

calf to dry feed as fast as possible: With the second week of life the calves are offered hay, calf pellets and water *ad libitum*. The rumen is repeatedly inoculated with 250-500 ml rumen fluid from healthy adults. If the calf does not eat in the third week, it is force-fed with small quantities of hay or broken grass cobs and starter pellets. Milk is offered only two times a day in reduced concentration and quantity (2 x 2.5-3.0 1).

Figure 1. Administration of a nutrient-electrolyte solution by means of an oesophageal feeder

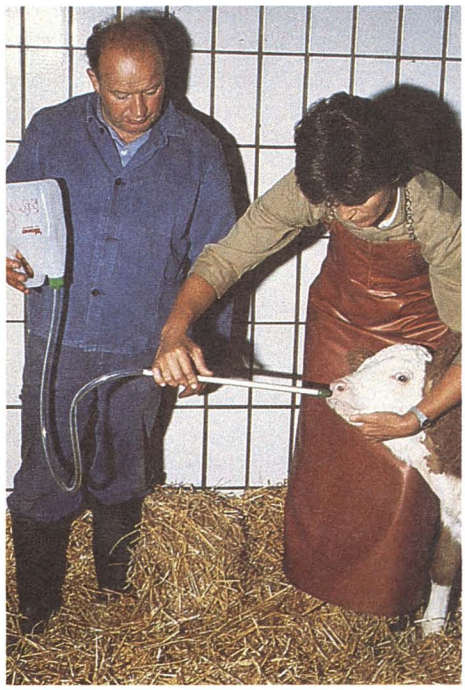

Figure 2. Emaciated force-fed calf suffering from rumen acidosis, blood acidosis and myodystrophy (white muscle disease). The calf has been cured

Outcome: Of the 23 calves treated in this way, 9 died or had to be euthanatized after hospitalization as indicated below:

day of hospitalization	1	2	3	9	11	17
no dead or euthanatized	2	1	2	2	1	1

The other 14 calves were cured and discharged after 3 to 17 days as listed below:

discharged on day	3	5	6	8	9	10	17
no. of calves	3	3	1	2	2	2	1

With the 2/3 day of treatment the animals drank the offered milk (cow milk at quantities of 10% of b.w.) voluntarily. In some calves, however, rumen auscultation and

Figure 3. A rumen fluid sample showing changes as with acidosis. It contained sloughed off pieces of the reticualr mucosa (right), indicating severe reticulitis and ruminitis

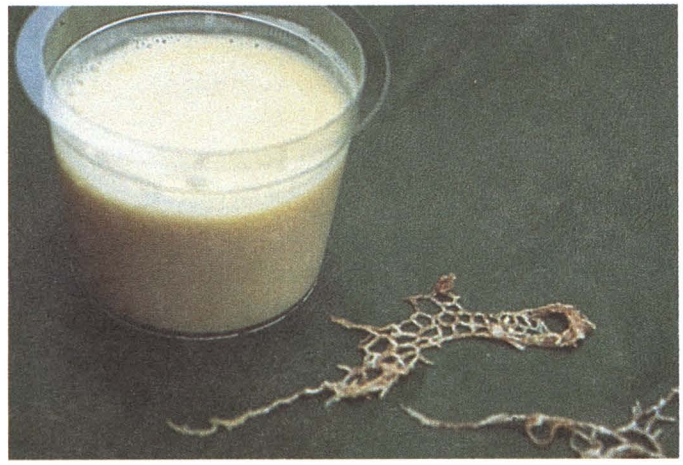

Figure 4. Dyskeratosis and reticulo-ruminitis due to ruminal drinking or force-feeding (Photo: Institute for animal pathology, University of Munich)

rumen fluid examination showed that the function of the oesophageal groove was not or not completely restored, so that they drank into the rumen. Treatment, therefore, had to be continued.

Post mortem findings: In five of the nine necropsied calves, a severe ruminitis with dyskeratosis/hyperkeratosis could be seen (Figure 4). Three of these animals had an advanced bronchopneumonia, in one of them with typical changes as with milk aspiration. Abomaso-enteritis, fibrinous arthritis and cachexia were reported for several calves of that group; in one calf fibrinous pericarditis and pleuritis as well as generalized pasteurellosis were observed, whereas another one showed purulent omphalophlebitis.

Conclusions

From the observations described above it can be concluded that force-feeding of new-born calves with liquid feeds or nutrient-electrolyte solutions containing easily digestible carbohydrates always includes the risk of fatty acids or lactic acid formation in the reticulo-rumen. In that case the breakdown processes occurring in the reticulo-ruminal cavity correspond to those observed in 'ruminal drinkers'. Repeated force-feeding with such liquids (with successive acid production) can induce or aggravate a metabolic acidosis and can lead to a pronounced reticulo-ruminitis. The energetic undernutrition, which develops under these circumstances, debilitates the animal additionally. That means that force-feeding of young calves with such liquids can cause a fatal sickness by itself.

Therefore, force-fed calves should be continuously controlled for rumen acidosis (or putrefication) by clinical examination, in particular by rumen auscultation during ballottement and rumen fluid aspiration as described previously (5). All therapeutical efforts should be directed to reduce force-feeding as soon as possible. If neonatal diarrhea obviously is the reason of the inappetence (and the force-feeding), one should shift early enough to parenteral fluid and electrolyte (and energy) replacement before the disorder has become irreversible.

Those calves which show sucking insufficiency directly after birth and do not improve during the following days, at first should be examined for local causes such as traumatisation of the tongue, inborn anomalies of the jaws or teeth, as well as for myodystrophy. Provided such reasons can be excluded, acquired or congenital defects of the CNS have to be taken into consideration. Those include defects due to asphyxia, to teratogenic agents, in particular intrauterine BVD infection or to genetical failures. The treatment of such calves is usually a frustrating task.

Summary

Previous studies have shown that so-called 'ruminal drinking' due to dysfunction of the ocsophageal groove can have severe consequences, not only in initially healthy veal calves, but also in new-born dairy calves suffering from various primary diseases. This paper describes the findings in 23 hospitalized calves (in 1989) with a history of having been force-fed repeatedly, 11 of them suffering from neonatal diarrhea, 12 being unable, too week or listless to suck. The liquid feeds which had been used were cow's milk, milk replacer, nutrient-electrolyte solutions or so-called 'diet drinks'. All of them contained easily digestible carbohydrates. Rumen fluid samples were aspirated on the day of hospitalization and were indicative of acidosis in 20 cases and for putrefaction in 3 cases.

A total of 52 rumen fluid samples were taken; on 7 occasions (16%) spontaneous outflow occurred when the suction head was introduced into the rumen. In 12 of the 23 force-fed patients a slight to severe metabolic acidosis could be observed. Treatment: adequate parenteral rehydration and acidosis therapy when necessary, (eventually repeated) rumen lavage, simultaneous stimulation of appetite, sucking reflex and function of the oesophageal groove by various measures; early weaning if treatment fails. Outcome: Of the 23 calves, 9 died or had to be euthanatized (5 on day 1 to 3 after hospitalization), 14 were cured. Five of the 9 necropsied calves had a severe ruminitis with dyskeratosis/hyperkeratosis. The findings show that force-feeding of new-born calves with liquid feeds or nutrient-electrolyte solutions containing easily digestible carbohydrates always includes the risk of fatty acids or lactic acid formation in the reticulo-rumen. Repeated force-feeding can induce or aggravate a metabolic acidosis and can lead to pronounced reticulo-ruminitis. Therefore, force-feeding can cause a fatal sickness by itself.

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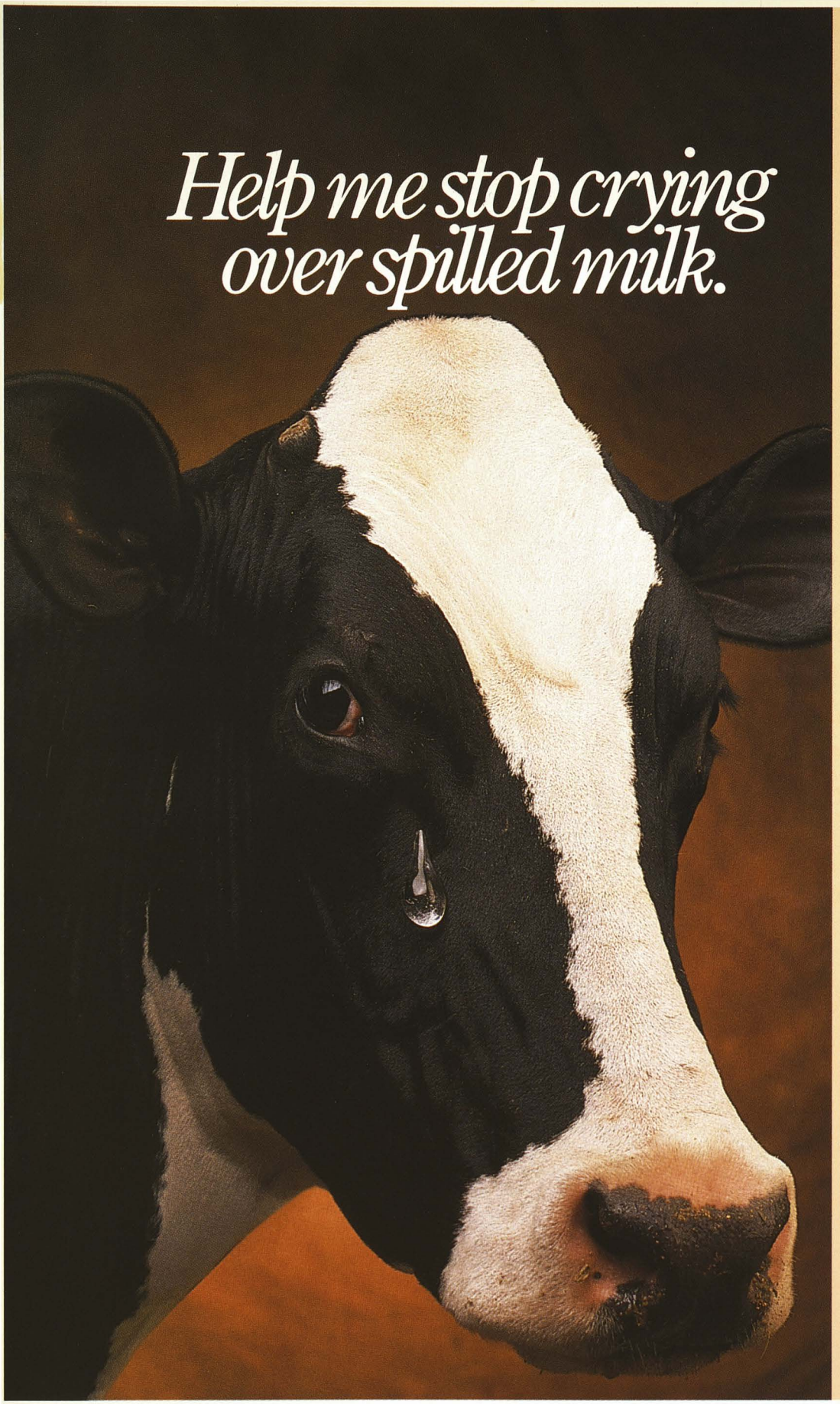

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