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# Use of Sodium Polyacrylate to Treat Gastrointestinal Obstruction of Cows Suspected of Omasal Impaction or Abomasal Impaction

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## Abstract

**Purpose:** For gastrointestinal obstruction of cows presenting a noticeable decrease of fecal amount probably due to omasal or abomasal impaction, traditional treatments such as correction of electrolyte imbalance and injection of antispasm drug and/or gastrointestinal prokinetic drugs are used. However, in many cases they result in low cure rate. To increase the rate, we examined the effects of sodium polyacrylate (PANa) as a lubricant on these treatments.

**Methods and results:** Ten grams of PANa dissolved in tap water were orally given via a polyethylene bottle (polybottle) or a nasal catheter to treat gastrointestinal obstruction of 19 cows suspected of omasal or abomasal impaction, in addition to treatments such as correction of electrolyte imbalance and injection of antispasm drug and/or gastrointestinal prokinetic drugs.

Using medical records, 61 cows diagnosed with omasal or abomasal impaction were selected for the traditional method group (hereafter, the control group) and were compared with the PANa combination group (hereafter, the study group). The cure rate in the control group was 16.4%, while that in the study group significantly ( $P < 0.05$ ) increased to 84.2%.

All cured cases in the study group were given PANa solution orally via a polybottle. The baseline blood test results revealed high levels of Ht and BUN and low levels of K and Cl, which returned to normal levels when normal fecal production was restored after the administration of PANa solution.

**Conclusion:** Oral administration of PANa solution via a polybottle in addition to traditional treatments can be a new treatment option for gastrointestinal obstruction of cows suspected of omasal impaction or abomasal impaction.

**Keywords:** Abomasal impaction; Cessation of defecation; Gastrointestinal obstruction; Omasal impaction; Sodium polyacrylate

## Introduction

Although cows take in a large amount of foods, the opening from the omasum to the abomasum is just the size of a golfball. Unlike other livestock, the gastric mucosa in the pylorus is well developed and thick and its lumen is narrow compared with that in the fundus [1].

Thus, it can be assumed that temporary contraction of the smooth muscle in the pylorus can trigger the obstruction of the food passage with undigested fibers and consequently this causes omasal or abomasal impaction. These conditions present with symptoms such as a noticeable decrease in fecal amounts or the arrest of fecal production, but the diagnosis is hard to make since there is no other particular symptom [2].

In the current case, the possibility of rumen impaction should be ruled out due to the noticeable decrease in fecal amounts, and likewise, abomasal displacement be ruled out due to the negative result in the left and right ping sound tests and the negative result in the splashing sound test of the right abdominal wall, and intestinal volvulus be ruled out due to the absence of hematochezia, colic pain, and palpable intestinal distention by the rectal examination.

From the blood biochemical point of view, diagnosis can be made when hypochloremia, which was induced when chlorine ions in the stomach acid are retained in the gastrointestinal tract due to upper gastrointestinal obstruction, is confirmed and accordingly, hypokalemia, to correct metabolic alkalosis associated with it, is confirmed [3-5].

Medical treatments for this symptom include medication of an antispasm drug, prifinium bromide [6], injection of gastrointestinal prokinetic drugs, neostigmine sulfate and metoclopramide hydrochloride [3], infusion of electrolyte correction solution, and oral administration of cathartics, magnesium sulfate and liquid paraffin [7]. However, the effects

are minimal and the number of surgical deaths is abounding [8-10].

PANa, the powder of superabsorbent polymer, absorbs water that is 100 to 1,000 times heavier than its self-weight to become sol with remarkable lubricity. It is a compound with a wide safety margin and is approved as a food additive for human use by the "US Food and Drug Administration" and "Ministry of Health, Labor and Welfare" (Japan).

In the livestock farming industry, it is also approved as a feed additive. In this study, we focused on the lubrication action of PANa to study whether the oral administration of it can be a new treatment of gastrointestinal obstruction of cows suspected of omasal or abomasal impaction.

## Materials and Method

### Tested cows

From among Holstein breeding cows that were raised in Nara Prefecture, 19 cows that presented with gastrointestinal obstruction and thus were suspected of omasal or abomasal impaction between 2013 April and 2014 March were provided for the test as the PANa combination group.

Diagnostic criteria were defined as having suspended fecal production with no symptoms such as hematochezia and colic pain i.e., a state of a noticeable decrease in fecal amounts or a vacant state of the rectum without feces), after losing appetite and even after presenting with feces with undigested fibers, dry indurated feces, or clear watery diarrhea, as well as having a negative result in the left and right ping sound tests, a negative result in the splashing sound test of the right abdominal wall, and showing no palpable distention of the intestine by rectal examination.

To form the control group, 61 cases of the medical record with the diagnosis of omasal impaction or abomasal impaction between 2010 and 2012 were examined to compare the cure rate between both groups.

### Treatment method

In the control group, treatment was carried out by combining injections using several agents, i.e. 7.2% hypertonic saline, Ringer's solution, 5% glucose infusion solution, prifinium bromide, neostigmine methylsulfate, and metoclopramide hydrochloride, with oral administration of edible oil, potassium calcium, and magnesium sulfate.

In the study group, 10 g of PANa (mol wt: 30,000~40,000) powder were given additionally on top of these agents. Specifically, 10 g of PANa powder were suspended in 500 ml of tap water and given orally via gavage using a polybottle to 17 cows, while 10 g of PANa powder were dissolved by 20 L of tap water and given using a nasal catheter to 2 cows.

Since PANa is not readily solvable, it was put into a bottle in small quantity and added with hot water, and then suspended by churning repeatedly. PANa was given again for 8 out of the 10 cases that did not show an increase in the fecal amounts even after its administration. Clinical cure was defined as the state of increased fecal amounts with resumed appetite. The cure rate was calculated by dividing the number of cured cases by the number of cases in total.

### Blood test

To confirm the presence of omasal impaction or abomasal impaction, the blood of PANa-pretreated 11 cows were tested in the study group. An automatic blood cell analyzer (Sysmex K-4500, Sysmex Corporation, Hyogo) was used to measure Ht levels, and a biochemistry analyzer (Sysmex K-4500, Sysmex Corporation, Hyogo) was used to measure blood Na, K, Cl, and BUN. To confirm the changes in blood property at pre- and post-treatment with PANa, one of the cows (ID No: #7) that were blood-tested before the administration of PANa was again blood-tested when fecal production was observed on the next day of the administration.

### Examination of PANa action on the passage of food fibers

One hundred grams of Total Mixed Rations (TMR) feed were put in a container with an opening of a golfball-sized diameter (ca.3 cm) and mixed with 500 ml of tap water or 500 ml of water dissolved with 1 g of PANa. The whole thing was vibrated using a mixer (Automatic Labo-Mixer NS-8, AS ONE Corporation, Osaka) and compared the state of effusion.

## Statistical Analysis

Fisher's exact test was used to test the cure rate in both groups. A significant difference was defined as  $p < 0.05$ .

## Results

### Examination of the lubricating action of PANa on the passage of food fibers

First, we examined what effect was brought about by PANa on the passage of fiber mixture through a golfball-sized hole (**Figure 1A**).

In the control group, where tap water and TMR fibers were mixed, only the liquid passed through the hole, leaving fibers in the container (**Figure 1B**). In contrast, when PANa was added to the fiber-mixture, all the content flew out slowly from the container just by adding vibration (**Figure 1C**).



**Figure 1:** Examination of the PANa effect on the passage of fiber-water mixture through the hole. A) Enlarged view of the opening of the bottle. B) 100 g of TMR feed mixed with 500ml of water and C) plus 1 g of PANa were put into the bottle

### Application of PANa to cows

The fecal properties of the 19 cows in this study were seen in various forms, such as undigested fibers, indurated fecal pellets, colorless malodorous liquid, and jelly mucus, and these cows

had either a noticeable decrease in fecal amounts or an arrest of fecal production. In the study group, all the cured 17 cows were given PANa via a polybottle, while the other 2 dead cows were via a nasal catheter (**Table 1**).

**Table 1:** Fecal properties, the number of examinations, the status of PANa administration, and the outcomes of cows with gastrointestinal obstruction suspected of omasal or abomasal impaction

ID number	Fecal properties	Number of examinations	Date of PANa administration	Methods	Outcomes
1	Small amount of fabric feces	2	1	Polybottle1)	Cured3)
2	Small amount of fabric feces	2	1	Polybottle	Cured
3	Jelly-like mucus/vacant state of the rectum	3	1	Polybottle	Cured
4	Small amount of fabric feces	6	1	Polybottle	Cured
5	Indurated feces	6	1	Polybottle	Dead
6	Clear watery diarrhea	2	1,2	Polybottle	Cured
7	Vacant state of the rectum	8	1,4	Polybottle	Cured
8	Jelly-like mucus/vacant state of the rectum	4	2	Polybottle	Cured
9	White gray viscid feces	5	2,3	Polybottle	Cured
10	White gray viscid feces	6	2,3	Polybottle	Cured
11	Vacant state of the rectum	6	3	Polybottle	Cured
12	Small amount of fabric feces	6	3	Polybottle	Cured
13	Jelly-like mucus/vacant state of the rectum	9	3,4	Polybottle	Cured
14	Clear watery diarrhea	10	3,5	Polybottle	Cured
15	Small amount of fabric feces	6	5	Polybottle	Cured
16	Viscid feces	11	5,6	Polybottle	Cured
17	Vacant state of the rectum	8	6,7	Catheter2)	Dead
18	Jelly-like mucus	14	8	Catheter	Dead
19	Vacant state of the rectum	11	9	Polybottle	Cured

1)10 g of PANa mixed with 500 ml of tap water was orally administered via a polybottle.

2)10 g of PANa mixed with 20 L of tap water was administered via a nasal catheter.

3)Clinical cure was defined as the state of increased fecal amounts with resumed appetite.

Cows that developed gastrointestinal obstruction and thus were suspected of having omasal or abomasal impaction were followed up steadily every year: 17, 23, and 21 cows in the year 2010, 2011, and 2012, respectively. The cure rate in the control

group was low at 16.4% (10/61) and more than 70% of cows died or became disused, while the cure rate in the study group was significantly high at 84.2% (16/19) (Table 2).

**Table 2:** Outcomes in terms of treatment methods of cows with gastrointestinal obstruction suspected of omasal or abomasal impaction

Consequence	Control group1)				Study group2)
	2010	2011	2012	Total in 3 years	
Death	9 (52.9) 3)	12 (52.2)	15 (71.4)	36 (59.0)	3 (15.8)
Disuse	3 (17.6)	4 (17.4)	3 (14.3)	10 (16.4)	0 (0.0)
Suspension	2 (11.8)	2 (8.7)	1 (4.8)	5 (8.2)	0 (0.0)
Clinical cure4)	3 (7.6)	5 (21.7)	2 (9.5)	10 (16.4)	16 (84.2)
Total	17 (100.0)	23 (100.0)	21 (100.0)	61 (100.0)	19 (100.0)
The number of treatments/cow	5.1±3.455)	5.0±4.05	5.9±2.08	5.2±3.68	6.6±3.36
1) In the control group, treatment was carried out by combining several gents, i.e. 7.2% hypertonic saline, transfusion material, gastrointestinal prokinetic drug, antispasm drug, KCl, MgSO <sub>4</sub> , and edible oil.					
2) In the study group, 10 g of PANA dissolved in tap water was given via a polybottle or a catheter in addition to traditional treatments.					
3) Number of cases; The numbers in brackets are shown in percentage.					
4) Clinical cure was defined as the state of increased fecal amounts with resumed appetite.					
5) Mean ± SD					

### Blood test results

Among 11 cows that were blood-tested before the treatment by PANA, a low level of Cl and K were observed in 8 and 10 cows,

respectively. The level of Ht was low in 2 cows but high in 5 cows, while the level of BUN was high in 5 cows (Table 3).

**Table 3:** Blood properties of cows with gastrointestinal obstruction suspected of omasal or abomasal impaction1

ID number	Fecal properties	Ht(%)	BUN(mg/dl)	Na(mEq/l)	K(mEq/l)	Cl(mEq/l)	Outcomes
3	Jelly-like mucus / vacant state of the rectum	<b>41.1</b>	9.0	139	<b>3.6</b>	97	Cured
6	Clear watery diarrhea	<b>38.9</b>	23.0	140	<b>3.7</b>	<b>89</b>	Cured
7	Vacant state of the rectum	24.9	ND	140	4.5	98	Cured
8	Jelly-like mucus / vacant state of the rectum	37.4	26.2	142	3.3	95	Cured
9	White gray viscid feces	<b>41.2</b>	<b>65.0</b>	132	<b>2.5</b>	<b>65</b>	Cured
11	Vacant state of the rectum	25.8	23.5	137	<b>3.3</b>	102	Cured
13	Jelly-like mucus / vacant state of the rectum	30.3	37.5	140	<b>2.7</b>	<b>90</b>	Cured
14	Clear watery diarrhea	31.7	18.5	140	1.9	89	Cured
15	Small amount of fabric feces	ND	20.8	<b>107</b>	<b>2.8</b>	<b>68</b>	Cured
17	Vacant state of the rectum	<b>40.3</b>	<b>40.9</b>	<b>128</b>	<b>3.6</b>	<b>81</b>	Dead
18	Jelly-like mucus	34.7	<b>26.6</b>	149	<b>2.0</b>	<b>93</b>	Dead
Normal level2)		27.6~35.6	10~25	132~152	3.9~5.8	97~111	
1) Blood was collected before the administration of sodium polyacrylate.							
2) Outline of Clinicopathological Tests in Livestock Mutual Aid (revised in 2005), National Agricultural Insurance Association							
Bold indicates a deviation from the normal level.							
ND: Not determined							

The high levels of Ht and BUN and low levels of K and Cl observed in one cow, which was blood-tested after its fecal

production resumed by the administration of PANa and returned to normal (**Table 4**).

**Table 4:** Fecal properties and blood properties of the cow (ID No: #8) at pre- and post-treatment with PANa.

Blood sampling time <sup>1)</sup>	Fecal properties	Ht(%)	BUN(mg/dl)	Na(mEq/l)	K(mEq/l)	Cl(mEq/l)
Pre-treatment	Jelly-like mucus /vacant state of the rectum	<b>37.4</b>	<b>26.2</b>	142	<b>3.3</b>	<b>95</b>
Post-treatment	Muddy stool	27.8	13.2	141	4.3	100
Normal level <sup>2)</sup>		27.6~35.6	10~25	132~152	3.9~5.8	971~11
1) Blood was collected at right before the oral administration of the solution of 10 g of PANa mixed with 500 ml of pure water via a polybottle and on the following day of administration.						
2) Outline of Clinicopathological Tests in Livestock Mutual Aid (revised in 2005), National Agricultural Insurance Association						
Bold indicates a deviation from the normal level.						

## Discussion

Traditionally, edible oil has been given expecting for lubrication action. The viscosity of salad oil is 65 mPaS while that of the PANa solution was extremely high at 90,000-115,000 mPaS, (BASF safety data sheet). As Figure 1 shows, in our model experiment where the mixture of TMR fibers and water was applied in the container having a golfball-sized hole, only the liquid passed through the hole, leaving fibers in the container, whereas in the presence of PANa all the content slowly passed through the hole. We thus believed that oral administration of PANa solution, which has an extremely high lubrication action, might have helped the undigested fibers that were retained in the omasum or the abomasum to become smooth and moved down to the lower gastrointestinal tract and subsequently solved electrolyte abnormality, leading to cure the symptom.

The fecal properties of the tested cows varied. However, these cows were diagnosed with omasal or abomasal impaction, since most of them had extremely decreased fecal amounts and were observed with hypokalemia and hypochloremia, though not all cows were blood-tested [4]. Since high levels in Ht and BUN were also confirmed, deterioration of the overall health status was also suspected.

The cure rate in the control group was extremely low at 16.4% and more than 70% of cows died or became disused, while the cure rate in the study group was significantly high at 84.2%, compared with the control group.

Medical treatments for omasal or abomasal impaction include releasing contraction of the pyloric smooth muscle, in addition to injecting antispasm drugs, i.e. prifinium bromide [6], and peristaltic movement promoters, i.e. neostigmine and metoclopramide, and correcting acid-base imbalance. Considering the effect of administering chlorine intravenously to make up for the shortage of it in a short time, injecting 7.2%

hypertonic saline and orally administering potassium, which cannot be fully supplied by intravenous administration alone, can be an option. However, these are all symptomatic treatments. As a surgical technique for this symptom, there is a report that the abomasum was cut open to remove the contents in the abomasum and the omasum, followed by abomasal cerclage and this resulted in the cure of the symptom [11]. However, the prognosis of surgical treatment is generally poor [8-10].

Only 2 cows were given PANa via a catheter, and the timing of which was rather late. Both cows died. All the cured cows were given PANa via a polybottle. It is known that reticular groove reflex occurs during feeding. However, from an anatomical point of view, the reticular groove is also developed in adult cows. Thus, when a small amount of foods pass through the esophagus, the rugae on the reticular groove react to it and form a tube-like shape to send the foods from the esophagus directly to the omasum [1]. It is reported that especially when ruminated porridge-like forage passes through the cardiac part of the stomach, the sorting function of the reticular groove reacts to it and sends the forage directly to the omasum [12]. PANa solution is a viscous gel, so we think that when it was given orally via a bottle, the reticular groove reflex occurred and PANa solution was directly sent to the target organ, the omasum, and exerted a lubrication effect. However, when given via a catheter, PANa was possibly diluted in the rumen and did not exert its effect.

As is reported, the omasal capacity and the abomasal capacity of a Holstein first-calf heifer is 7.2 kg and 3.3 kg, respectively [13]. However, since PANa absorbs water that is 100 to 1,000 times heavier than its self-weight to become lubricant, we defined the dosage amount to be 10 g. Considering that there may be cases where a one-time dosage will not be effective, reconsidering dosage might be necessary.

In Japan, death and disuse of cows due to omasal or abomasal impaction amount to more than 600 cases in a year. This has not decreased at all in the past 10 years, meaning that little progress in treatment has been made (Source: Statistical Tables of Livestock Mutual Relief, 2004~2014, the Ministry of Agriculture, Forestry and Fisheries). No study using PANa has yet been reported in an overseas complete book or treatment reports [2,9,14-17].

## Conclusion

Taken all these together, oral administration of PANa solution using a bottle in addition to traditional treatment methods can be considered as a new, easily practicable option to treat gastrointestinal obstruction suspected of omasal or abomasal impaction.

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