Bloat In Young Calves
& Other Pre-ruminant Livestock

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Bloat results from a variety of factors, but the common thread throughout bloat cases is production of gas by organisms in the digestive tract. Feed equipment, feed temperature, feed ingredients, amount fed, feeding frequency, water availability, weather, stress etc., may be involved, but they do not cause bloat by themselves. Organisms, and not necessarily the pathogenic ones, produce the gas that causes bloat. Keeping these relationships in perspective can be a big help when it comes to figuring out how various components fit together to create a specific bloat situation.

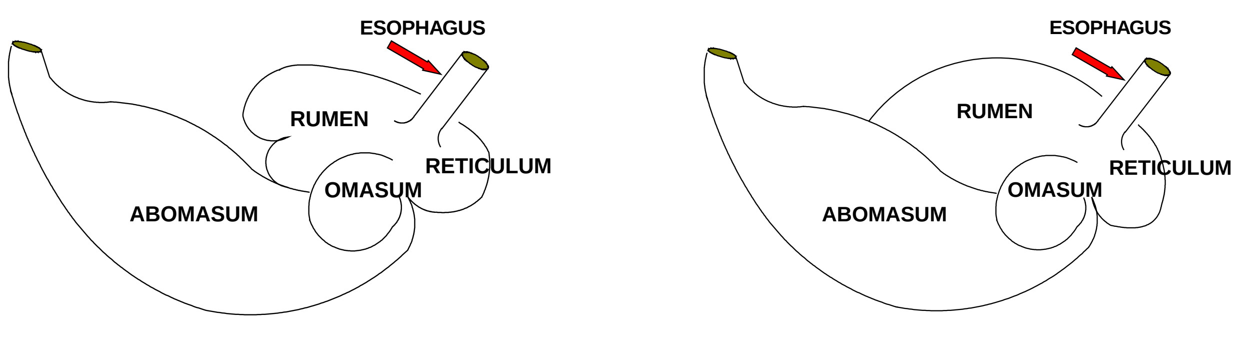
Susceptibility of individual animals to bloat is variable and genetics may play a part in some cases. Bloat can be a chronic problem on some farms and never occur on others. Heifer growers that raise calves for more than one client or from more than one farm location may notice that calves from one farm regularly have bloat problems while calves from other farms remain bloat free. Although working through a bloat problem can be truly frustrating, many contributing factors can be controlled to prevent bloat or to at least minimize its occurrence.

Rumen Development – *Changes in Digestive Function and Structure*

The pre-ruminant stomach is made up of the same four structures or compartments as the adult ruminant stomach. At birth, the abomasum is the dominant structure while the rumen is basically non functional. As the calf consumes various feeds and water, its rumen gradually develops and increases in size and digestive function. Bloat can affect either the abomasum or the rumen. Since the nature of abomasal bloat is quite different from that of ruminal bloat, it is important to have some understanding of what's happening inside the calf's stomach as the calf grows from a pre-ruminant into a ruminant animal.

Figure 1 shows changes in the calf's stomach from birth to about 8 weeks of age, by which time many dairy calves have been weaned. During the first two weeks of life, the calf is essentially monogastric with a simple stomach, the abomasum, to digest milk components. As the calf consumes dry feed and water, the rumen begins to develop and becomes more important.

Figure 1. Rumen Development From Birth To Weaning



Birth to 2 weeks **6 - 8 weeks**

At birth, the abomasum accounts for about 70% of the volume of the entire stomach. By eight weeks of age, the rumen has increased in size and function to the point where the abomasum provides about 50% of the total stomach volume. By the time the animal reaches maturity, the abomasum accounts for less than 10% of the total volume, (Figure 2, Table 1) while the rumen, reticulum and omasum make up the remainder.

Figure 2. Rumen Development From 3 Months To Maturity

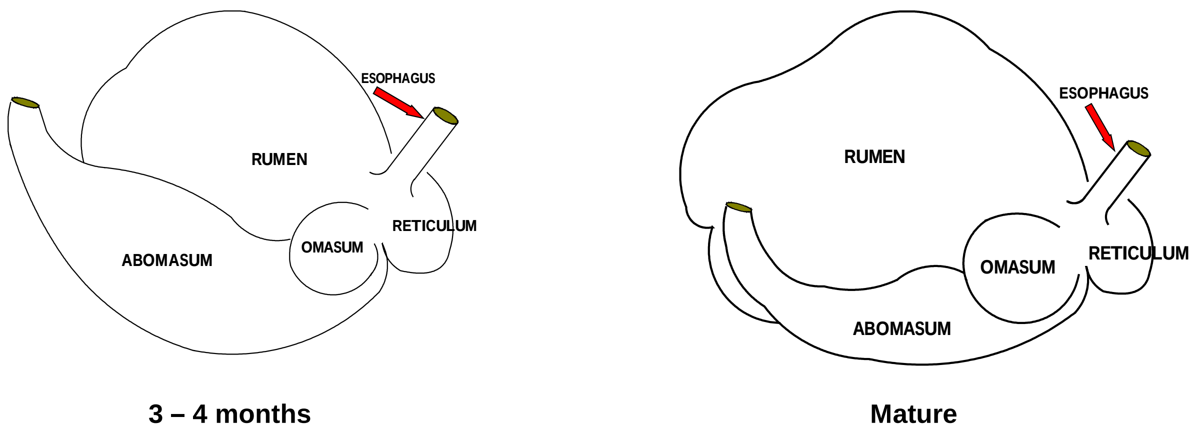
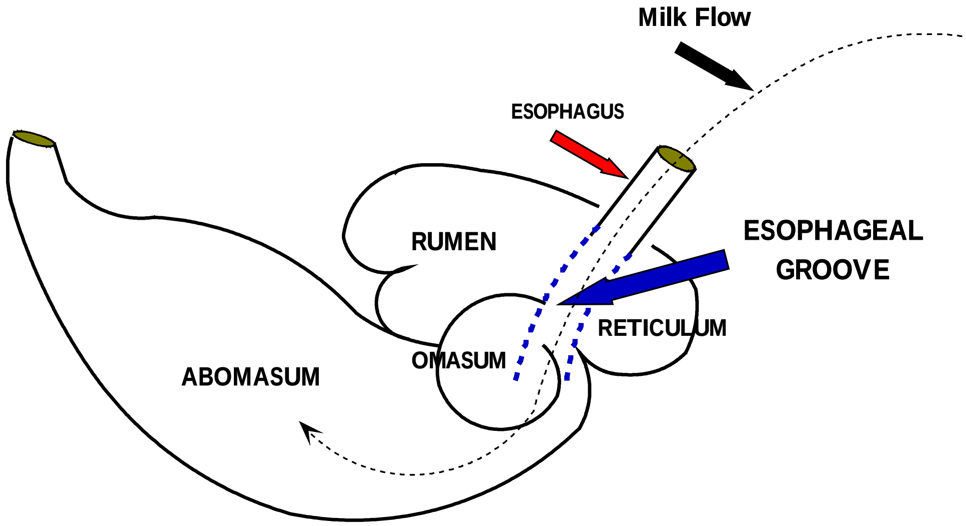


Table 1. Relative Size Of Stomach Compartments From Birth To Maturity

	Percentage Of Stomach Capacity	
Age	**Abomasum**	**Rumen/Reticulum/Omasum**
Birth to 2 weeks	**70**	**30**
8 weeks	**50**	**50**
3 – 4 months	**25**	**75**
Maturity	**<10**	**>90**

Esophageal Groove (reticular groove). After feed is swallowed, it moves down the esophagus toward the stomach. Since the esophagus joins the stomach in the area of the rumen and reticulum, ingested feed first enters this section of the stomach. However, prior to weaning, milk and milk replacer take a different route. A combination of factors such as suckling, the presence of milk proteins and anticipation result in neural responses that cause muscular folds in the reticulorumen (esophageal groove) to contract. This closes the opening from the esophagus to the rumen allowing milk and milk replacer to pass directly from the esophagus to the abomasum. Figure 3. Closure of the esophageal groove allows milk and milk replacer to bypass the rumen, reticulum and omasum.

Figure 3. The Esophageal Groove



Types of Bloat -- *Abomasal Bloat*

Abomasal bloat in calves and other pre-ruminant livestock is often rapidly progressive and life threatening. The processes involved in abomasal bloat are not completely understood. A rapid growth or proliferation of organisms results in production of an excessive quantity of gas that cannot escape the abomasum. This causes severe distention, seen along the animal's right side, which compresses the abdominal and thoracic organs (heart, lungs) and the blood vessels that lead to them. The result is asphyxiation and heart failure.

The abomasum of an affected calf usually becomes grossly distended within 1hour after feeding with death occurring within a few minutes after the distention becomes clinically obvious. At necropsy, the abomasum is grossly distended with gas, fluid and milk or milk replacer. Treatment of abomasal bloat is very difficult. Attempts to release the gas with a stomach tube will not likely be successful since the esophageal groove is not present to guide tube movement. Limited success has been achieved by inserting a needle into the abomasum through the distended right flank of the animal to release some of the gas.

Factors contributing to abomasal bloat include overfeeding milk or feeding milk too fast. In the presence of fermenting bacteria, a large quantity of milk or milk replacer arriving at the abomasum can provide an excellent substrate for these bacteria to grow rapidly and ferment sugars. Excessive gas is produced as a result of this rapid fermentation. The pH of the abomasum becomes more acidic as these sugars are processed, resulting in a detrimental effect on other bacteria. The end result is overproduction of gas that cannot escape.

Lambs. Sarcina bacteria have been reported in association with some cases of abomasal bloat in lambs. The presence of Sarcina in the digestive tract should not be considered unusual. What appears unusual in these cases is that Sarcina, a fermenter, multiplies very rapidly producing reddish areas or abcesses in the abomasal wall. These weak spots can actually lead to abomasal rupture under severe gas pressure.

(continued)

If milk replacer is fed, cooling the mixture to at least 40^{O} Fahrenheit (4^{O} C) before feeding has been reported to help contain the growth rate of Sarcina. This may reduce the incidence of bloat on farms where Sarcina has been found in association with abomasal bloat. Milk replacers should still be mixed according to manufacturers instructions prior to cooling.

The rapid growth of certain pathogens, such as Clostridium, can also lead to abomasal bloat. *Clostridium perfringens* are commonly found in young calves with types A and C being the most common cause of disease. Clostridia cause enterotoxemia, an acute intestinal infection, and kill through the production of a systemic toxin. Clostridia are normally found in the intestine of cattle and can survive for months in the soil. Overeating or abrupt diet changes tend to produce indigestion that slows gut movement, providing the sugars, proteins and lack of oxygen needed for rapid growth of Clostridia. Wet conditions also seem to favor this organism.

Clostridial infections of the intestines are uncommon in young calves. There are many more cases of clostridial infection that involve the abomasum, usually in calves between two and five weeks of age. *Clostridium perfringens* Type A causes stomach irritation and can lead to abomasal ulcers and bloat. Affected calves may stop eating, show uneasiness and strain or kick at their abdomen. Calves are often found dead without having shown any previous symptoms. Moderate bloating of the abomasum is often found.

There are a variety of other factors that can contribute to abomasal bloat. These include impaction of the abomasum or intestines with non-feed substances such as bedding or hairballs. An animal may even have structural or physiological problems with the abomasum that lead to improper functioning and bloat.

Types of Bloat – *Ruminal Bloat*

Ruminal bloat occurs when gas produced during rumen fermentation builds up in the rumen and is unable to escape. Gas becomes trapped in the upper area of the rumenoreticulum. Normal rumen contractions decrease and belching becomes impossible, preventing gas from being expelled. As gas accumulates, abdominal swelling can be observed behind the rib cage on the left flank. Ruminal bloat can become life threatening within a few hours and usually requires medical attention. Treatment of individual bloat cases can be as simple as gently inserting a flexible stomach tube coated with mineral oil into the esophagus down into the rumen to release some of the trapped gas. A little mineral oil administered through the stomach tube may facilitate gas release in some cases. In severe cases, inserting a large gauge needle or a trocar through the left flank of the animal, puncturing the rumen, may be required to save the animal's life. Follow-up treatment for peritonitis may be needed.

Rumen development - conditions for bloat. Ruminal bloat in young calves takes place within the context of the developing rumen. The size and make-up of the population of rumen microbes that exists at any point in time is determined by the types of feed consumed as well as other substances commonly ingested such as bedding and hair. The right set of circumstances can allow one or more of these microbes to produce excessive gas and bloat in the developing rumen.

Rumen development begins in earnest when water and dry feed come together in the rumen. To assure adequate development, a dry starter feed should be made available as soon as the calf is placed on milk or milk replacer. Intake of starter will be low until the calf is a couple of weeks old, but it is still of major importance to rumen development. Butyric and propionic acids are volatile fatty acids (VFA) that are produced from grain digestion. Although butyric acid has the greatest effect, both stimulate rumen development. Feeding hay on the other hand, produces another VFA, acetic acid, which provides poor stimulation for rumen development. Since hay is not required for rumen development prior to weaning, it should be withheld from the diet until after the calf is weaned.

When dry feed is consumed, it enters the rumen. For bacterial growth and feed digestion to occur, a liquid environment is needed. Since milk and milk replacer contain a readily digestible and fermentable energy source, it is preferable that they stay out of the rumen. The esophageal groove directs milk to the abomasum preventing it from directly entering the rumen. When milk persistently flows into the rumen, calves may develop a number of symptoms including unthriftness, growth retardation, poor appetite, abdominal distention, recurrent bloat, hard feces and a long dry hair coat. Calves that are restricted to a liquid diet, such as veal calves, are more likely to develop these symptoms.

Since the esophageal groove may still be present for a while after milk feeding, water fed immediately after milk usually passes directly to the abomasum. For water to enter the rumen and facilitate feed digestion and rumen development, it must be fed separately from milk and milk replacer. A minimum of 10 minutes has been suggested as the necessary waiting period before offering water after milk feeding. Even so, water added to a bucket that still contains some milk or milk replacer may stimulate reformation of the esophageal groove. The general recommendation is to feed 4 pounds of water (2 qt) for every pound of dry feed consumed. Table 2 shows how the amount of water a calf requires changes as the calf grows.

The amount and quality of water provided and the microbial population it contains can have significant effects on rumen development and function. Under the right set of circumstances, management practices that slow down or impede rumen development can set the stage for bloat and other digestive problems.

Table 2. Estimated Water Intake of Heifers

Body Weight (lb)	Gallons Per Day	
	at 40°F	at 80°F
100	0.7	1.1
200	2.0	3.3
400	3.7	6.1
600	5.0	8.4
800	6.3	10.6
1000	7.3	12.3
1200	8.0	13.4

Source: Extension Circular 385, The Pennsylvania State University

Management factors that can influence the incidence of ruminal and abomasal bloat

In addition to dry feed and water management there are many other factors that can contribute to the occurrence of ruminal bloat in pre-ruminant animals. As a matter of fact, many of these factors are the same ones that contribute to abomasal bloat. Management practices to consider include:

- *Colostrum Management.* Ensuring a newborn calf receives an adequate supply of high quality colostrum at the right time is the single most important factor in preparing the animal to withstand disease challenges during the first few weeks of life. The importance of colostrum to the animal's health and well being cannot be overstated. This becomes more apparent when pathogens are involved. To enhance colostrum quality by improving the antibody levels against certain disease organisms, specific dry cow vaccinations may be appropriate (ie Clostridium).

- *Feeding Time.* Feed at the same time each day. Variable feeding times can cause calves to become very hungry. Hungry calves eat and drink quickly and often over-eat, leading to changes in digestion. Feed volume and feed types should also be consistent with any changes being made gradually -- no sudden changes.

- *Milk Feeding Temperature.* Under normal circumstances, milk and milk replacer should be fed at body temperature, about 103^0 F. Cold temperatures may alter milk intake as well as the rate of feed passage. However, feeding cold milk replacer (40^0 F) has been reported to restrict the growth rate of Sarcina in the abomasum, thereby reducing the incidence of abomasal bloat in lambs on farms where Sarcina has been identified.

- *Feeding Equipment.* Feeding equipment, especially equipment used to feed milk should be cleaned and sterilized before each use. Dirty, contaminated equipment is a sure-fired way to introduce and spread unwanted microbes to calves. Ensure feeding equipment is in good condition. Do not cut the ends of nipples so calves drink milk faster or use deteriorated nipples that have developed large holes.

- *Antibiotics.* Milk replacers containing an antibiotic such as Oxytetracyline/Neomycin Base have been reported to reduce the incidence of bloat on some farms. Antibiotics affect the bacterial population in the digestive tract and may produce a positive effect on the incidence of bloat. Certain milk replacer additives such as Merrick's Super Guard Type B Medicated Feed provide Oxytetracycline/Neomycin Base that can be added to non-medicated milk replacers on-farm. Oxytetracycline/Neomycin Base is not, however, approved for incorporation into milk replacers for lambs and kids. Medications that target coccidia, such as Deccox and Bovatec, are not antibiotics and would not be effective against bacteria.

- *Feed Ingredients.* The importance of dry starter feed and water in rumen development has already been discussed. The starter must be palatable. It should not be something the calf grudgingly eats to keep from starving. Research conducted by the University of Wisconsin and the University of Minnesota found that 19-20% crude protein is the optimal protein level for calf starters. Other nutrients need to be properly balanced and particle size should be sufficient to help stimulate rumen function and development. The fiber level of milk replacer is a key measure of milk replacer quality. Ingredients such as soy proteins tend to increase the fiber content from 0.15% to 0.5% or higher. Milk replacer cost goes down, but so does calf performance to some degree..Although a large volume of soy flour milk replacer is manufactured and used without incidence, soy flour contains anti-nutritional factors that can cause intestinal inflammation. Such a stress can alter digestive function and cause digestive disorders that can lead to bloat. These anti-nutritional factors are reduced with additional processing of the soy flour into soy protein concentrate.

- *Stress.* Stress causes physiological and behavioral responses. Changes in management and environmental often lead to stress. Vaccination, dehorning, feed and housing changes are routine stressors that most calves are subjected to within a very short period of time. Careful attention needs to be paid to calves as they undergo these changes. Subjecting the calf to several of these stressors at once can have significant health effects. Changes in weather, both short term and seasonal can lead to major nutritional and health challenges. Efforts must be made to minimize the impact these conditions have on calf health.

- *Health Status*. The overall health status of the calf can certainly affect its predisposition to bloat. A calf that succumbs to repeated bouts of scours or respiratory problems, perhaps from inadequate colostrum intake, may be far more likely to develop the digestive conditions most conducive to bloat. On the other hand, an aggressive, fast growing calf with only restricted access to water for part of each day, may develop eating and drinking patterns that facilitate the rapid growth of gas producing bacteria. Treatments such as antibiotic therapy may diminish bacterial populations in the digestive tract. The same may be true for calves that receive large amounts of oral electrolyte solutions via an esophageal feeder. The large volume of water entering the rumen may wash away a portion of the rumen microbes. Although the treatment may have been effective, these calves may be more susceptible to digestive challenges until microbial populations are re-established.

Summary. Bloat in pre-ruminant animals results from a combination of factors. The common element found throughout all cases of bloat is microbial fermentation of energy sources resulting in the production of gas that is unable to escape. Abomasal bloat would typically be observed as severe distention on the right side of the animal while ruminal bloat results in distention of the left flank. The list of possible scenarios that can result in bloat is a long one. The management issues and examples described above are provided more to stimulate thought and facilitate evaluation rather than to provide a complete list of bloat causes. By evaluating and adjusting management practices many contributing factors can be eliminated or controlled to minimize the occurrence of bloat.

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