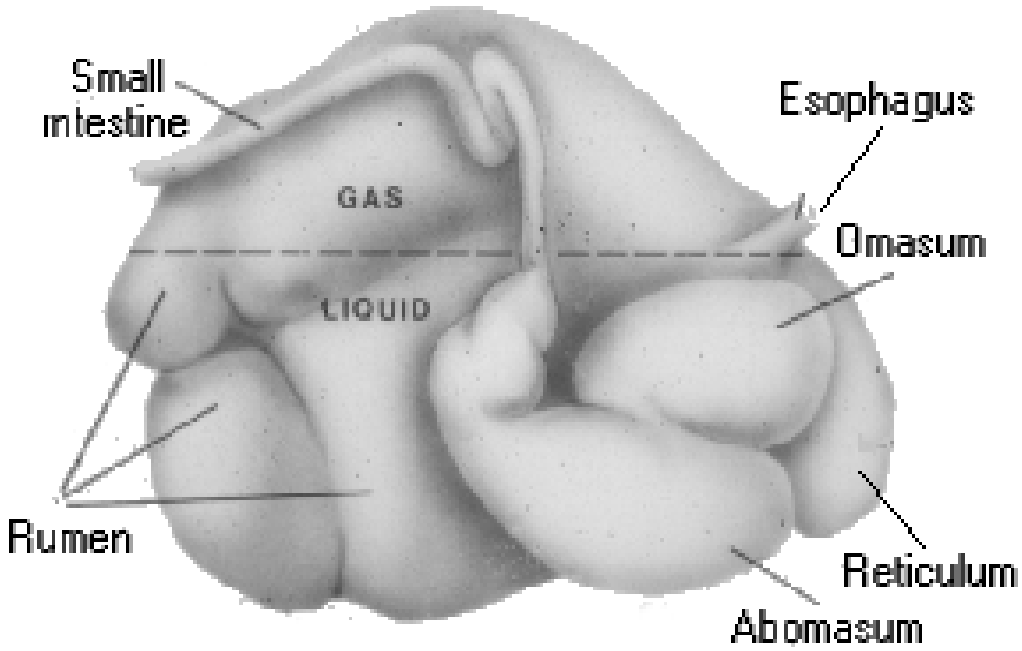
Compound Stomach Surgery

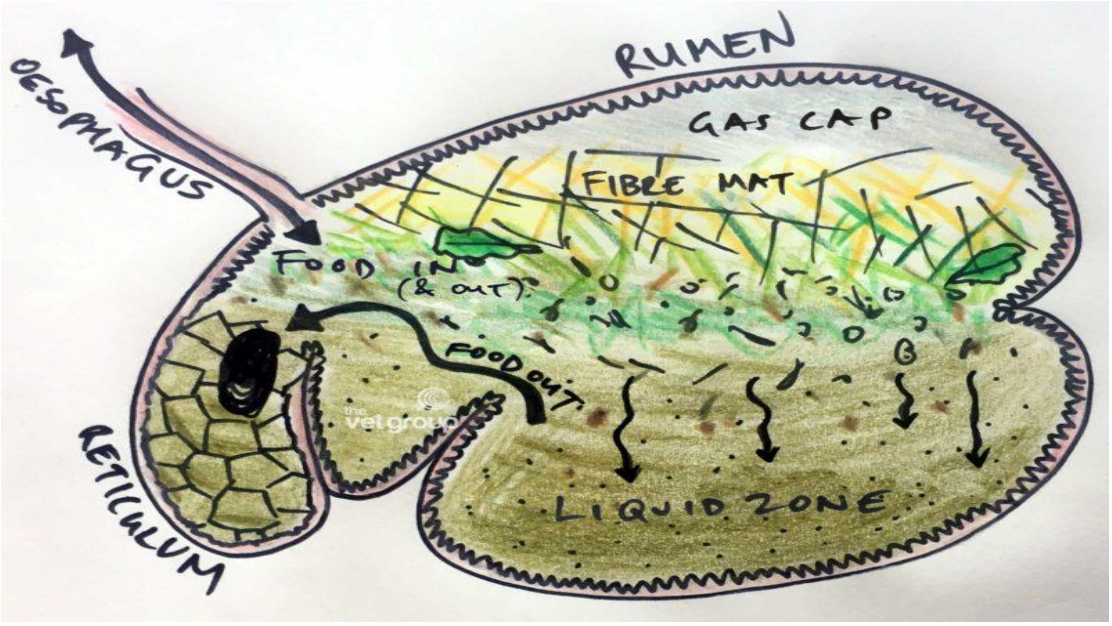
The stomach of ruminants has four compartments: the rumen, reticulum, omasum and abomasum, as shown in the following diagram. Collectively, these organs occupy almost 3/4ths of the abdominal cavity, filling virtually all of the left side and extending significantly into the right. The reticulum lies against the diaphragm and is joined to the rumen by a fold of tissue. The rumen, far and away the largest of the forestomaches, is itself sacculated by muscular pillars into what are called the dorsal, ventral, caudodorsal and caudoventral sacs. In many respects, the reticulum can be considered a "cranioventral sac" of the rumen; for example, ingesta flows freely between these two organs. The reticulum is connected to the spherical omasum by a short tunnel. The abomasum is the ruminant's true or glandular stomach. Histologically, it is very similar to the stomach of monogastrics. The interior of the rumen, reticulum and omasum is covered exclusively with stratified squamous epithelium similar to what is observed in the esophagus. Each of these organs has a very distinctive mucosa structure, although within each organ, some regional variation in morphology is observed.



The rumen

The rumen (on the left side of the animal) is the largest stomach compartment and consists of several sacs. It can hold 25 gallons or more of material depending on the size of the cow. Because of its size, the rumen acts as a

storage or holding vat for feed. Aside from storage, the rumen is also a fermentation vat. The rumen's environment favors the growth of microbes. These microbes digest or ferment feed within the rumen and make volatile fatty acids (VFAs). The rumen absorbs most of the VFAs from fermentation. A good blood supply to the rumen walls improves absorption of VFAs and other digestion products. Tiny projections (papillae) line the rumen, which increases the rumen's surface area and the amount it can absorb.



Rumen Physiology and Rumination

The rumen is a fermentation vat *par excellance*, providing an anaerobic environment, constant temperature and pH, and good mixing. Well-masticated substrates are delivered through the esophagus on a regular schedule, and fermentation products are either absorbed in the rumen itself or flow out for further digestion and absorption downstream.

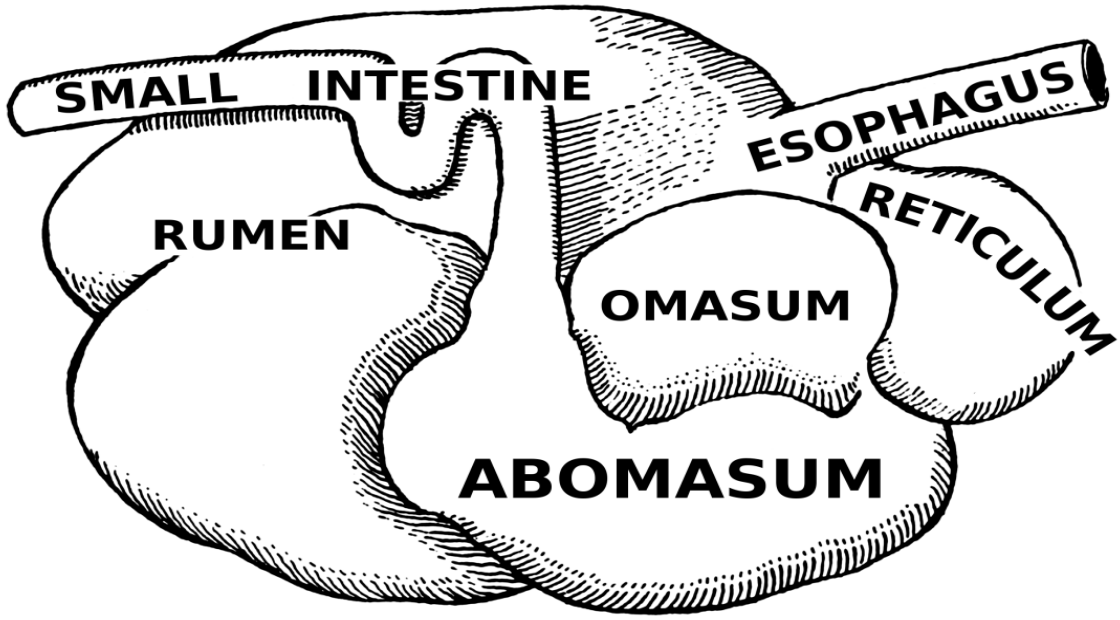
Ruminants evolved to consume and subsist on roughage - grasses and shrubs built predominantly of cellulose. Despite the fact that some ruminants, feedlot steers for example, are feed large quantities of grain, this section will focus on a ruminant's "natural diet".

The reticulum

The reticulum is a pouch-like structure in the forward area of the body, close to the heart. The tissues in the reticulum form a network similar to a honeycomb. A small tissue fold lies between the reticulum and rumen, but the two aren't separate compartments. Together they're called the rumino-reticulum.

The omasum

The omasum is a globe-shaped structure containing leaves of tissue (like pages in a book). It absorbs water and other substances from digestive contents. Feed material (ingesta) between the leaves will be drier than ingesta found in the other compartments.



The abomasum

The abomasum is the only compartment lined with glands. These glands release hydrochloric acid and digestive enzymes, needed to breakdown feeds. The abomasum is similar to a nonruminant stomach.

Affection of Compound Stomach

Rumen surgery

Rumen fistulation (Rumenostomy) : that mean abnormal opening between inside the rumen toward the out. The fistula may be enquired or induced, Chronic recurrent ruminal tympany usually occurs in calves of three to nine months. Condition causes unthriftiness resulting from reduced feed intake. Fistula affords symptomatic relief and is rapidly produced.

Etiology of recurrent tympany

Often caused by inadequate fibre intake and poor rumen development. Occasionally there is obstruction of thoracic oesophagus and/or cardia by external pressure by mediastinal lymphadenopathy, which may be sequel to chronic pneumonic pathology. Stomach tube can often be passed without any difficulty, so excluding possibility of mechanical stricture or stenosis.

Signs

Slight but progressive loss of condition associated with more or less permanent overdistension of rumen. Many such calves eventually recover spontaneously. Rumination is usually unaffected.

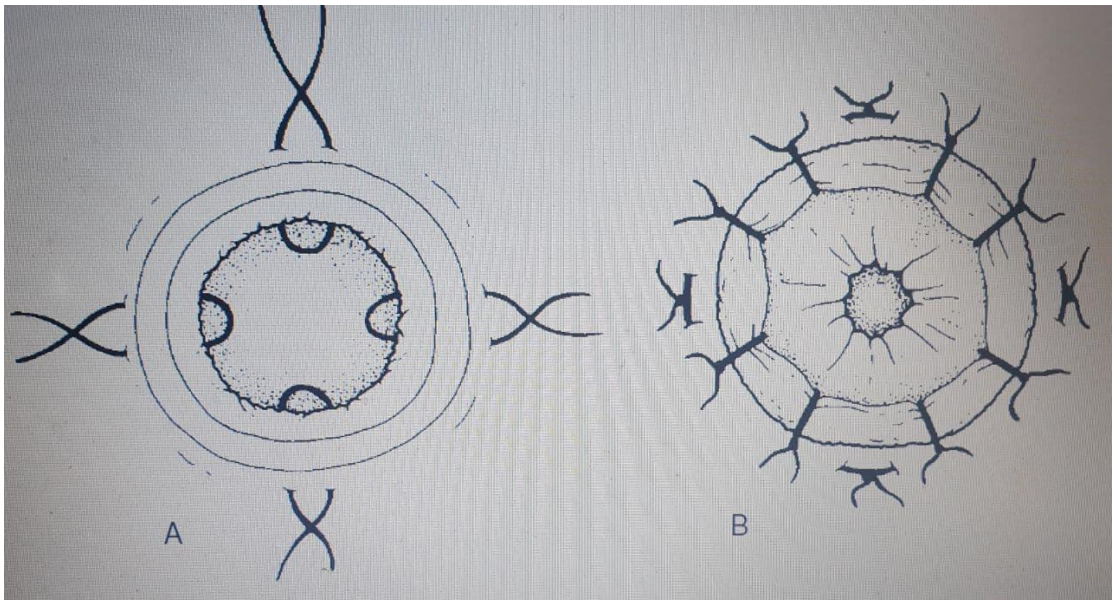
Treatment

Technique

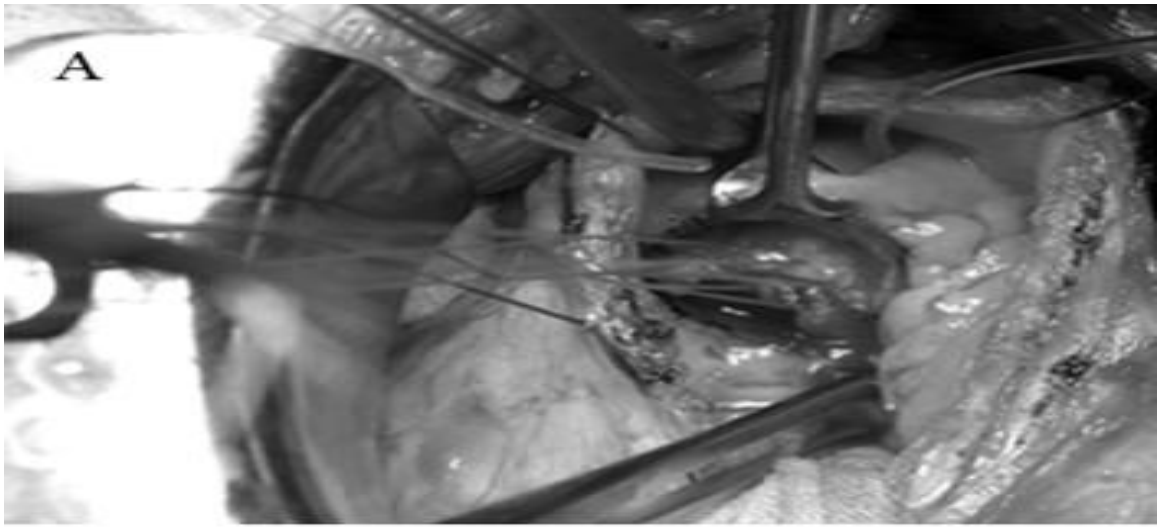
• paravertebral analgesia (T13, L1, or localinfiltration analgesia. Site is upper left paralumbar fossa, one third of distance from last rib to external angle of ilium
• clip skin over site 10 × 7 cm and disinfect
• pass stomach tube to relieve any tympany
• remove oval section of skin 4 × 2 cm, and split muscularis by blunt dissection (scissors)
• pick up peritoneum with Allis forceps, incise, and grasp
• exteriorise underlying ruminal wall with second Allis forceps
• place sutures (polyamide) between skin and rumen using interrupted horizontal mattress pattern or simple continuous stuture for initial fixation (see Figure A)

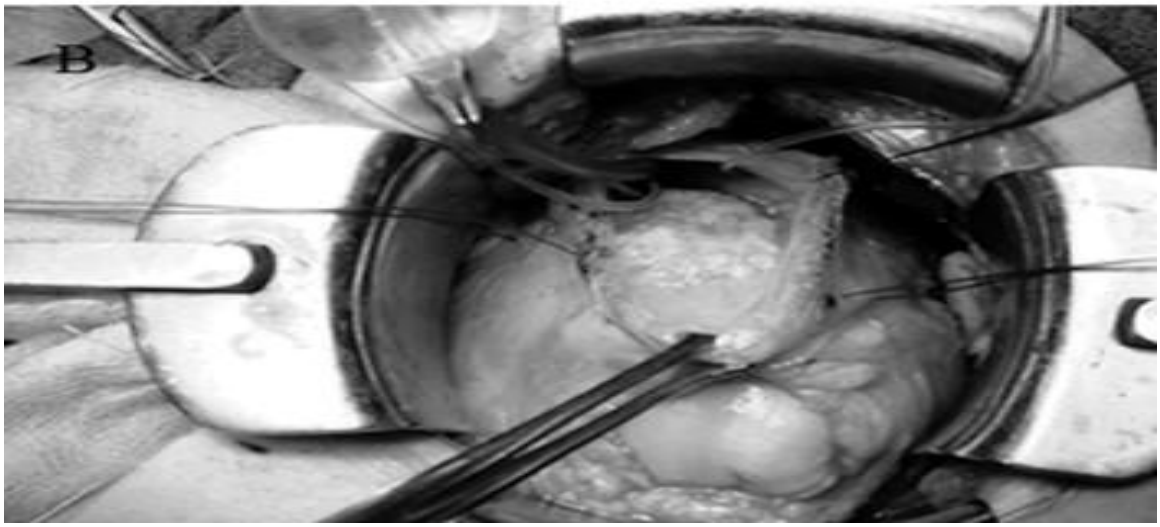
Alternatively, a screw trocar (Buff model) may be inserted through flank for several weeks as needed. Problems can occur: lumen blockage, displacement out of rumen, peritonitis

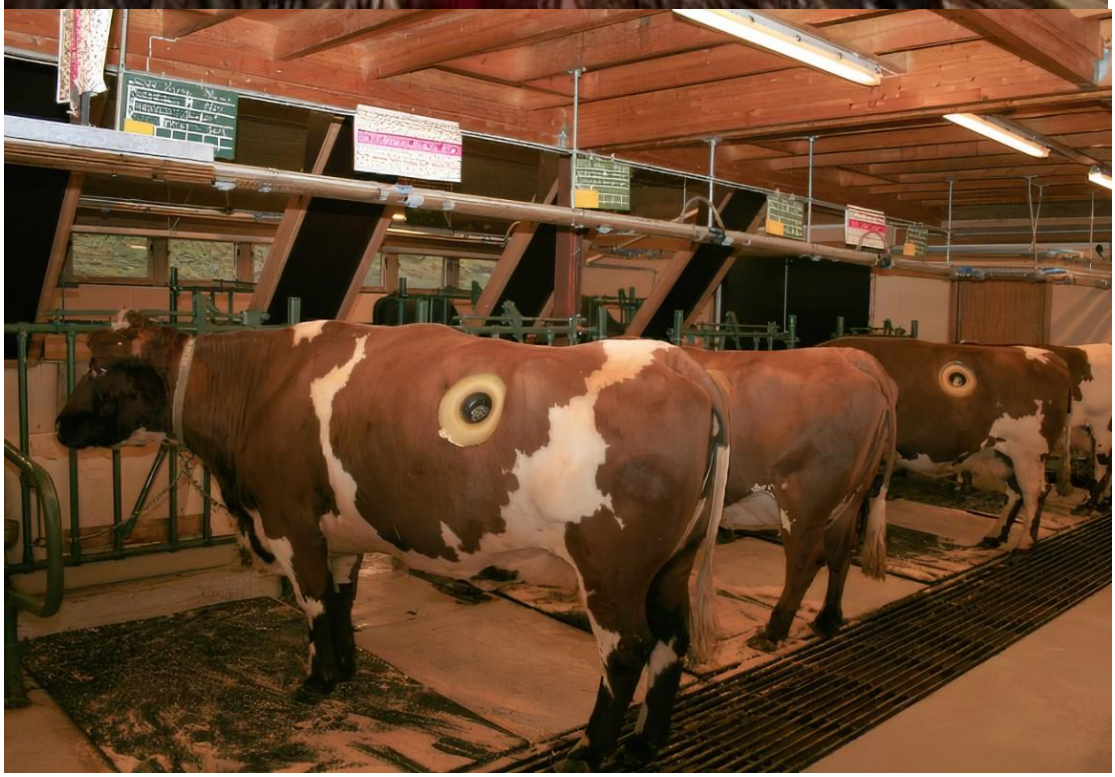
• incise rumen (3 cm) and place four or eight simple sutures to overlap rumen and skin margin (see Figure below)
• if thought necessary, convert slit into oval by removing portion of wall slightly smaller than the previously resected skin



This ruminal incision usually heals in three to five weeks following fibrous tissue proliferation and stricture. A permanent fistula requires a ruminal incision at least 6 cm long.







Postoperative care

- NSAIDs are continued for 2-3 days, antibiotics for 5 days
- The flank is coated with vaseline and cleaned as needed to minimize scalding from the rumen juices.
- Nonabsorbable sutures are removed at 10-14 days
- Without a cannula, the rumenostomy site will gradually shrink and eventually close in most situations. If sized appropriately, the bloat should be resolved by the time it closes.

Complications

- Peritonitis- animals may have a fever and be off feed. Some cattle can wall off the infection.
- Incisional infection- part of the suture line may need to be opened to allow drainage.
- Skin scald – can be treated with cleaning, zinc oxide and vaseline
- Lack of closure – with constant manipulation from cleaning or continued cannulation, the site will stay open. It can be closed if needed. Closure involves resecting the fistula and should be done by an experienced surgeon.

Diseases need Rumenotomy

Surgical opening of the rumen by making the incision on the wall of rumen is known as rumenotomy. Rumenotomy is a routine procedure for treating many diseases in ruminants.

Indications

a)exploratory surgery, e.g. in chronic intermittent rumen tympany Persistant ruminal impaction.
b) Frothy Bloat.

c) Foreign bodies lodged in distal esophagus, rumen, and reticulum.
d) Traumatic reticulitis.
e) Atony of omasum and abomasum.
f) Reticular herniorraphy.
g) Exploratory rumenotomy for diagnosis of intraruminal diseases. other than foreign bodies.
h) Ingestion of toxic plants.
i) Diaphragmatic hernia.

Technique of rumenotomy

Rumenotomy is the preferred treatment for acute traumatic reticuloperitonitis, and is also indicated in suspicious cases of chronic disease which are nonresponsive to conservative treatment including chemotherapy, administration of a permanent magnet, and management change. Site is in left flank as described in exploratory laparotomy. Length of incision should be 18–25 cm, but varies somewhat with the particular technique selected to control possible contamination by ruminal contents:

- **Weingart frame – incision as above**
- **McLintock cuff – incision length 16 cm**
- **Suture of ruminal wall to parietal peritoneum** – no critical length. Ensure in all cases that dorsal commissure of incision is about 8 cm ventral to lateral extremity of lumbar transverse processes. Having entered abdominal cavity and before making rumenotomy incision check several points:
- appearance of visible parietal and visceral (ruminal) peritoneum, e.g. roughening indicative of acute or chronic peritonitis
- explore right side of abdominal cavity first
- presence of excessive abdominal fluid: pass hand ventrally, and excessive abdominal fluid is easily obtained in handfuls, i.e. repeated volumes of 20–50 ml. A greyish-yellow colour with floccules of pus is evidence of acute or chronic peritonitis
- presence of adhesions between reticulum, and diaphragm and adjacent viscera: indicative of past or present foreign body penetration. For assessment of age of adhesions. To avoid potential contamination of the abdominal cavity by ruminal contents, the ruminal lumen is either exteriorised (Weingart frame or McLintock cuff) or the abdominal cavity is sealed off from the rumen by temporary insertion of a continuous suture. The preferred method is the Weingart frame.

Weingart frame method

The stainless steel frame (size 27 × 18 cm) is used with two vulsellum forceps (23 cm) fixed with single hooks near the junction of blade and handle, and with six small (7 cm) tenaculum hooks. Having entered abdominal cavity:

• screw the Weingart frame into the dorsal commissure of the skin incision
• push ruminal contents inwards at intended rumenotomy incision
• grasp rumen wall dorsally and about 15 cm ventrally with the two pairs of forceps, exteriorise and fix to two rings at top and bottom of frame. This brings out the rumen but does not yet prevent contamination
• place a sterile cloth or rubber drape or shroud completely around the exteriorised rumen between the frame and the abdominal wall
• incise the rumen just below the dorsal forceps
• insert one of the small ruminal hooks into the ruminal mucosa near the edge, pull back and clip the rumen onto edge of the frame
• extend ruminal incision ventrally to an appropriate length for entry of

McLintock cuff method

This method is equally efficient but presents greater problems with sterilization of equipment, and rubber components eventually perish.

• a special rubber cloth with everted stiff cuff surrounding the abdominal incision is placed over the flank
• exteriorise rumen and make 2.5 cm incision in upper position
• insert rubber-covered hook which is held temporarily by a non-sterile assistant
• extend incision ventrally to 10–11 cm length

Weingart frame placed to exteriorise and fix ruminal wall with six hooks and two vulsellum forceps.

• insert rim of stiff rubber cuff through the incision, whereupon the lips of the ruminal incision will grip it tightly, and pull of rumen draws rim against skin of flank
• place a thin rubber sheet with 15 cm elliptical hole between rumen and skin
• place another, similar sheet over the rim and double back the edge of ruminal cuff to form a seal

Suture method

• suture ruminal wall to skin by simple continuous suture of non-absorbable material (4 metric) on cutting needle and to rumen with Cushing-type pattern

• after suturing, check site for a good seal between rumen and skin
• incise rumen starting 2.5 cm ventral to dorsal commissure and ending 3 cm dorsal to ventral commissure
• if rumen is not relatively empty and flaccid, these sutures can possibly tear out, and in such doubtful cases suture ruminal wall to edge of parietal peritoneal incision
• for easy handling when working alone, dorsal and ventral parts of exteriorised rumen may be temporarily fixed to skin by towel clips (13 cm)

For suturing purposes

Regardless of method, the next steps are similar:
• siphon off any excessive fluid with wide bore (3 cm internal diameter) plastic tubing filled with water, and remove any obstructing solid material
• pass arm cranially and ventrally over U-shaped ruminoreticular pillar and explore reticulum methodically. Evidence of adhesions already palpated during intra-abdominal exploration may lead hand to a particular area otherwise make initial rapid examination of the reticular floor, then of cranial wall.
• identify and examine the cardia, oesophageal groove, and the reticuloomasal opening as well as the medial wall: touching of reticulo-omasal orifice should provoke contraction.
• remove loose reticular foreign bodies, but search specifically for pointed longitudinal foreign body lodged in secondary reticular cells between the secondary crests which characterise this organ
• search with fingertips as only 1 cm or less length of foreign body may protrude into lumen. In other cases it can subsequently be confirmed that the foreign body has passed right through the reticular wall
• it may be helpful to elevate the reticular wall with fingers to assess the presence of adhesions out of reach on parietal surface, e.g. right side
• palpate reticular wall also for discrete abscesses
• if penetrating foreign body is found, and before its removal note depth and direction of penetration to consider the likely structures damaged at this time. This aids prognosis. The wisdom of puncturing and draining reticular or ruminal wall abscesses from the ruminoreticular lumen should be carefully assessed
• use a magnet to retrieve loose ferrous material more easily
• consider placing permanent magnet into reticulum

Difficulty in reaching furthest points for exploration due to physical size of the animal or surgeon may be partially overcome by elevation of the forequarters, causing reticulum to drop back slightly, or indirect pressure on reticular area by

upward pressure on the xiphoid region by an assistant (or two, using a wooden plank).
Ruminal medication may be given after exploration of the reticulum.
Although awkward to obtain (unless from slaughterhouse) fresh ruminal contents quickly normalise the flora.

Treatment of adhesions

• chronic adhesions: there is usually little or no benefit from breaking down chronic adhesions, which tend to reform very rapidly
• recent adhesions: do not break down since they may mask and surround an abscess cavity

Closure of ruminal incision

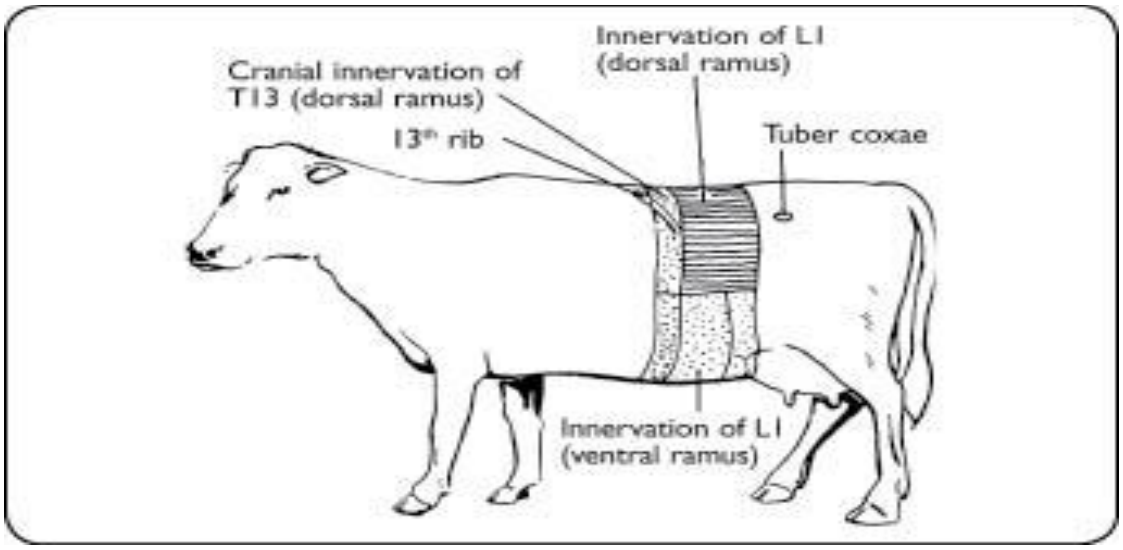
Method varies slightly with the method of fixation, but in all instances two layers of inversion sutures should be placed. These should be:
• continuous Cushing inversion suture of 4 metric PDS
• continuous Lembert inversion suture of similar material

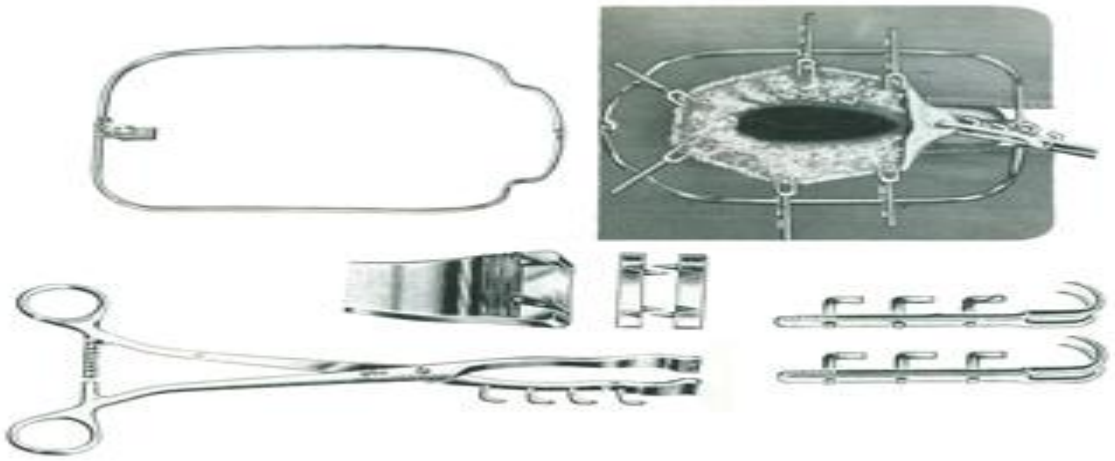
Weingart frame method

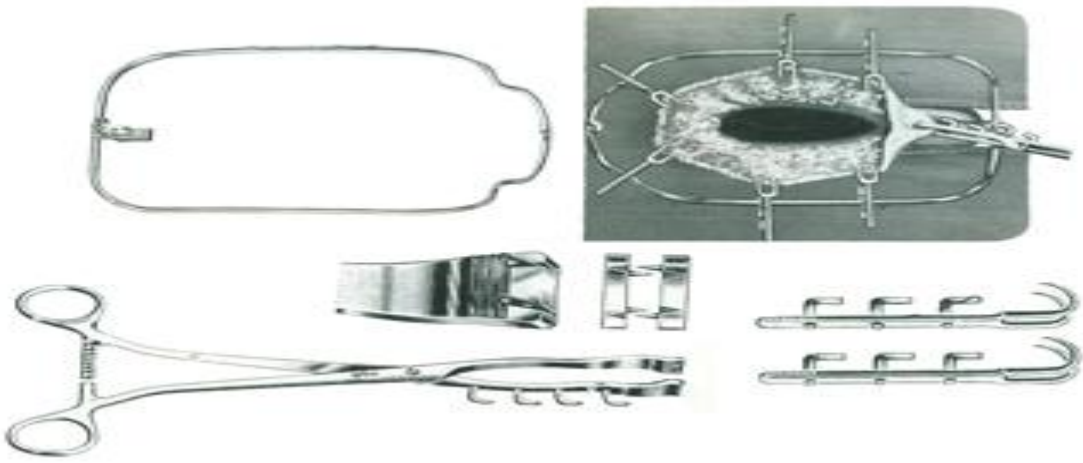
• remove the small ruminal clips and clean the peritoneal surface before and after placing the two suture layers, and clean again before releasing large forceps, permitting rumen to drop back into abdominal cavity.

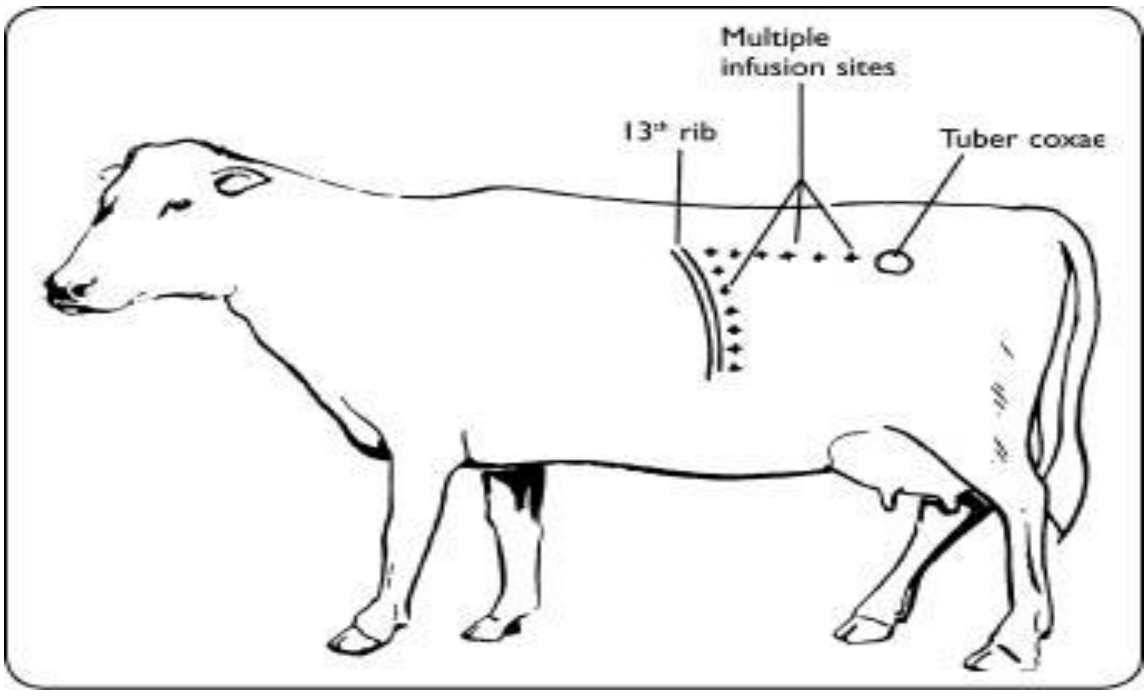
McLintock cuff method

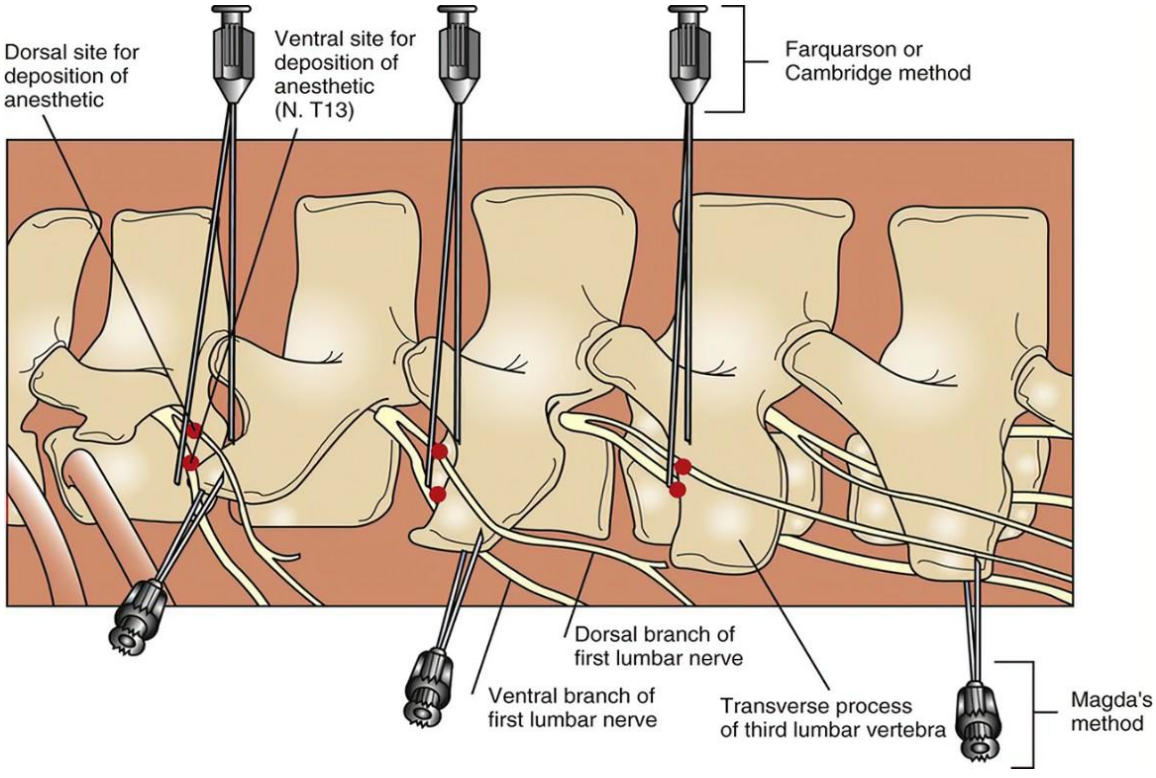
• remove the two rubber sheets, avoiding contamination, pull out rumen and internal cuff further from body wall and apply foam-rubber edged special rumen clamp under rim of tube which is then removed
• clamp then rests on flank with ruminal edges safely fixed and the contaminated surfaces may be easily cleaned, and the two layer suture (Cushing or Lembert type) placed in position
Suture method
• after initial cleansing of exposed ruminal surface insert two layers of sutures and then carry out thorough cleansing of the surfaces
• débride any contaminated tissue from the body wall musculature
• remove the circumferential peritoneal suture
should receive systemic antibiotic therapy for three to ten days.


Innervation of L1
(dorsal ramus)
Cranial innervation of
T13 (dorsal ramus)
13th rib
Tuber coxae
Innervation of L1
(ventral ramus)









Reticulum affection

Traumatic Reticuloperitonitis

It is common in cattle, buffaloes, rare in camel

Definition:

Small, sharp objects like nails, needles, piece of wire or piece of glass are frequently swallowed by ruminants. These commonly lodge in the area of the reticulum, where they may penetrate the wall and cause an inflammatory reaction.

The animal show clinical signs when significant reticulitis develops or when penetration of the wall occurs with subsequent acute local peritonitis.

Pathogenisis:

Sharp objects lodge in the reticulum partly because of the honycomb-like structure of the mucosal surface and partly because of its active contraction.

Penetration by a foreign object exposes the tissues to infection and cause local peritonitis.

The animal becomes clinically ill and develops anorexia and signs of acute abdominal pain.

Lactating dairy cattle will have a sharp drop in milk production.

Squeal to acute traumatic reticulitis include traumatic pericarditis, acute diffuse peritonitis, chronic localized peritonitis, chronic diffuse peritonitis, hepatitis, splenitis, pneumonia and pleuritis, and the vagus indigestion syndrome. In rare cases acute haemmorhage will cause sudden death.

Recurrences may be observed at any time but are more common during estrus period of increased physical activity, and late gestation.

Clinical signs and diagnosis:

The onset is sudden in the acute disease with complete anorexia.

Drop in milk production.

Fever (39 - 40 C) and decreased ruminal motility.

Local pain in the region of the xiphoid cartilage is manifested by a characteristic grunt following precaution.

The animal is reluctant to lie down or move.

Respiratory movement are mostly shallow and thoracic.

Constipation from reduced feed intake and dehydration, but animals that develop diffuse peritonitis may have diarrhea.

Metal-detector have been used to detect metal in the reticulum, but has serious limitations. X-ray is the best method for diagnosis.

Other conditions to consider in the differential diagnosis are lactation ketosis, abomasal displacement, rumen acidosis and other acute inflammatory conditions, such as metritis, nephritis and endocarditis.

Treatment:

Rumenotomy is effective in cases in which the foreign body remains embeded in the wall of the reticulum or the problem is caused by non ferrus foreign material.
Conservative method by adminstration of a rumen magnet to immobilize the foreign object and the use of antibiotic to control infection.

Prevention of traumatic reticulitis

Prevention may be difficult to achieve. However, advent of plastic bale twine and disappearance of wire has removed a major source of potential foreign bodies. Encourage at-risk farms to remove ferrous and other potentially hazardous materials from field and lane edges (e.g. during hedge-trimming). Consider, where economically justified (especially AI centres and pedigree stock farms), use of permanent magnets (Bovivet® ruminal magnet, Kruuse) given orally, from one year old onwards. Best type is cage model in which a plastic case surrounds magnet so that most ferrous material lies within the grooves, avoiding any contact with the reticular epithelium (Hannover model cage magnet super 11). Magnet appears an effective prophylactic measure.

Omasal Impaction

1. Omasal impaction occurs secondary to rumen impaction and may be a result of poor qualtity feed.
2. The omasum gets distended with stagnation of ingesta and its engorgement due absorption of fluids. Such animals are anorectic, listless and show signs of dehydration.
3. The auscultation at the level of right elbow at the 9th intercostal space will show complete absence of omasal sounds. Using a stomach tube, few litres of water and 4-5L of liquid paraffin or mineral oil are administered to soften the contents.
4. Two to three kg of sugar or jaggary is given along with about 50 tab of yeast and 2-3L of rumen liquor collected from a healthy animal, inorder to stimulate rumen flora. The rumen is then massaged with fist and knee.
5. In case of failure of this treatment, rumentomy is performed and solutions are injected directly into the omasum using a tube inorder to dislodge the contents.
6. Neglected cases may succumb with in few days due to the necrosis of omasal folds an account of pressure from its contents.

Abomasal Affection

1. Left Displaced Abomasum
2. Right Displaced Abomasum
3. Abomasal Volvulus
4. Abomasal Ulcers
5. Dietary Abomasal Impaction

Left Displaced Abomasum , Right Displaced Abomasum and Abomasal Volvulus

Because the abomasum is suspended loosely by the greater omentum and lesser omentum, it can be moved from its normal position on the right ventral part of the abdomen to the left or right side (LDA, RDA), or it can rotate on its mesenteric axis while displaced to the right and lateral to the liver abomasal volvulus (AV). The abomasum can shift from its normal position to left displacement or to right displacement over a relatively short period. AV can develop rapidly or slowly from an uncorrected RDA.

Etiology:

Although LDA, RDA, and AV (previously incorrectly referred to as right torsion of the abomasum) are often considered separately, there is evidence of a common underlying etiology; they may be different manifestations of the same or a similar disease process. The etiology is multifactorial, although abomasal hypomotility and dysfunction of the intrinsic nervous system are thought to play an important role in development of displacement or volvulus. Important contributing factors include abomasal hypomotility associated with hypocalcemia and possibly hypokalemia, as well as concurrent diseases (mastitis, metritis) associated with endotoxemia and decreased rumen fill, periparturient changes in the position of intra-abdominal organs, and genetic predisposition, particularly in deep-bodied cows. Genetic predisposition is correlated with milk yield, indicating that current selection practices for milk production are increasing the incidence of abomasal displacement. Hypomotility is also related to ingestion of high-concentrate, low-roughage diets, which reduce abomasal motility through a poorly defined mechanism that may involve hyperinsulinemia or increased concentrations of volatile fatty acids.

Clinical Findings:

1- The typical history of abomasal displacement includes anorexia (most commonly a lack of appetite for grain with a decreased or normal appetite for roughage) and decreased milk production (usually significant but not as dramatic as with traumatic reticuloperitonitis or other causes of peritonitis). In AV, anorexia

is complete, milk production is more markedly and progressively reduced, and clinical deterioration is rapid. In abomasal displacement, temperature, heart rate, and respiratory rate are usually normal. The caudal part of the rib cage on the side of the displacement may appear "sprung." Hydration appears subjectively normal with displacements except in some chronic cases. Rumen motility may be normal but often is reduced in frequency and strength of contraction. Feces are usually reduced in quantity and more fluid than normal.

2- The most important diagnostic physical finding is a ping on simultaneous auscultation and percussion of the abdomen, which should be performed in the area marked by a line from the tuber coxae to the point of the elbow, and from the elbow toward the stifle. The ping (detected during simultaneous percussion and auscultation) characteristic of an LDA is most commonly located in an area between ribs 9 and 13 in the middle to upper third of the left abdomen

3- The clinical signs associated with abomasal volvulus are more severe than with simple displacements because of the vascular compromise.

4- Without therapy, the animal often becomes recumbent within 48–72 hr after developing volvulus. Death occurs from shock and dehydration and is sudden if the ischemic abomasum ruptures.

Diagnosis:

For displacement or volvulus, diagnosis is based on the presence of the characteristic ping on simultaneous auscultation and percussion and exclusion of other causes of left- or right-side pings. Ultrasonography may be helpful in confirming a diagnosis of LDA, RDA, or AV, but it cannot reliably differentiate RDA from AV. Recent parturition, partial anorexia, and decreased milk production suggest displacement. A ketosis that is only temporarily responsive to treatment is consistent with abomasal displacement, which may be intermittent. The typical signs on physical examination (in addition to the ping), rectal examination, and laboratory evaluation also support the diagnosis. Melena or signs of peritonitis (eg, fever, tachycardia, localized abdominal pain, pneumoperitoneum) with an LDA may indicate a bleeding or perforated abomasal ulcer, respectively. In cattle with AV, blood l-lactate concentrations ≤2 mmol/L indicate a positive outcome with surgical correction, whereas cattle with blood l-lactate concentrations ≥6 mmol/L have a high probability of a negative outcome.

Treatment:

Open (surgical) and closed (percutaneous) techniques can be used to correct abomasal displacements. Rolling a cow through a 180° arc after casting her on her right side corrects most LDAs; however, recurrence is very likely. LDA can be corrected surgically using right flank pyloric omentopexy, right paramedian abomasopexy, left paralumbar abomasopexy, combined left flank and right paramedian laparoscopy (two-step procedure), or left flank laparoscopy (one-step procedure). Blind suture techniques (toggle-pin fixation or the "big needle" [blind-stitch] method), performed in the right paramedian area, are percutaneous methods for correction of LDA; however, the exact location of the suture is not known. Potentially fatal complications can develop after blind suture techniques, and the reported success rate is less than that of surgical correction by right flank pyloric omentopexy. With toggle-pin fixation, the pH can be checked to confirm that the pin is in the abomasum, which reduces the likelihood of attaching rumen, small intestine, or omentum to the body wall rather than the abomasum. RDA and AV are corrected surgically (using right paralumbar fossa omentopexy) when economically feasible. The right paramedian abomasopexy should be used only to correct RDA and AV in cattle unable to stand.

Ancillary treatment of animals with abomasal displacement include treating any concurrent disease (eg, metritis, mastitis, ketosis). Calcium borogluconate or calcium gluconate SC or calcium gels PO help restore normal abomasal motility in many cases. Administration of erythromycin (10 mg/kg, IM) at the time of surgery increases abomasal emptying rate and milk production in the immediate postoperative period. Because surgical correction of abomasal displacement or volvulus is frequently done on the farm, the prokinetic effect of erythromycin suggests that it might be preferred if antimicrobials are administered to control intraoperative infection. However, administration of an antimicrobial for a nonantimicrobial effect should not be promoted.

In simple displacement, fluid and electrolyte abnormalities correct spontaneously with access to water and a salt block. Providing electrolyte water (60 g sodium chloride and 30 g potassium chloride in 19 L of water) via stomach tube is helpful in cases of longer duration. Animals with significant dehydration and metabolic derangement require IV therapy, typically administered as hypertonic saline (7.2% NaCl, 5 mL/kg, IV over 5 min).

Occasionally, animals with abomasal displacement or volvulus have atrial fibrillation, thought to be of metabolic origin and primarily due to concurrent

hypokalemia and metabolic alkalosis. Correction of the displacement or volvulus almost always results in correction of the atrial fibrillation within 5 days.

Aggressive treatment of ketosis plays an important role in successful treatment of abomasal displacement, because most of the cattle that die after surgical correction of LDA and RDA do so from the metabolic consequences of prolonged anorexia.

The prognosis after correction of simple LDA or RDA is good, with survival rates of 95%. AV has a variable and less favorable prognosis (average survival rate of 70%); a high heart rate, moderate to severe dehydration, a longer period of illness, a large quantity of fluid in the abomasum, increased blood or plasma l-lactate concentration, and the presence of omasal-abomasal or reticulo-omasal-abomasal volvulus are associated with a poorer prognosis.

Prevention:

The incidence of abomasal displacements can be decreased by ensuring a rapid increase in rumen volume after calving, feeding a total mixed ration rather than feeding grain twice daily (“slug feeding”), avoiding rapid dietary changes, maintaining adequate roughage in the diet, avoiding postparturient hypocalcemia, and minimizing and promptly treating concurrent disease and ketosis.