Gastric Dilatation - Volvulus

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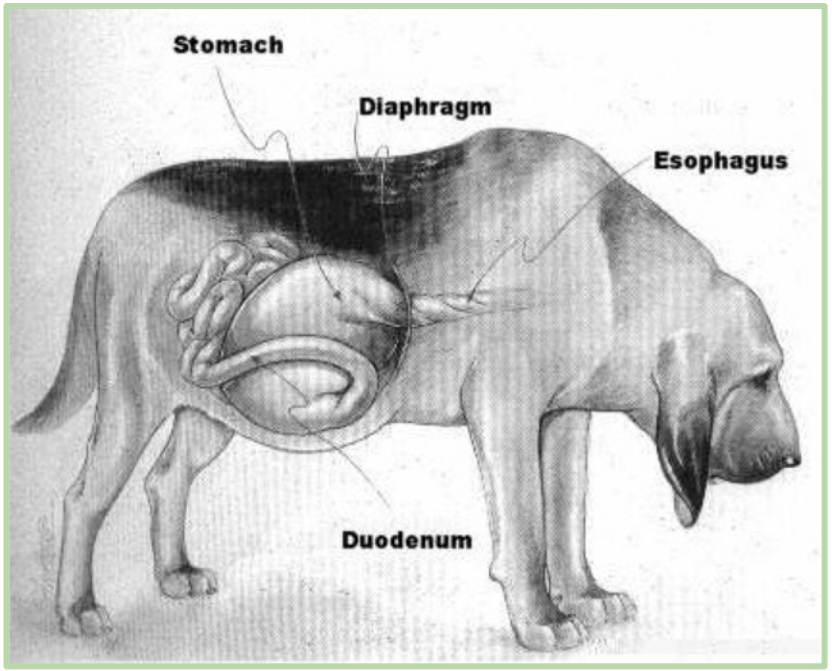
What is GDV?

- A very serious condition that occurs in susceptible dogs when the stomach becomes distended with air, and then while dilated, twists on itself

Why is It Important to Recognize?

- This is an acute, life-threatening situation which requires immediate medical and surgical intervention



Signalment

- ✧ Adult
- ✧ Large to giant breed dogs
- ✧ Deep chest conformation



Breed and GDV Risk Ratio

Glickman - JAVMA 217(10), 2000

1	Great Dane	**41.4**	14	Alaskan Malamute	**4.1**
2	St. Bernard	**21.8**	15	Chesapeake Bay Ret	**3.7**
3	Weimaraner	**19.3**	16	Boxer	**3.7**
4	Irish Setter	**14.2**	17	Collie	**2.8**
5	Gordon Setter	**12.3**	18	Labrador Ret	**2.0**
6	Standard Poodle	**8.8**	19	Eng Spring Span	**2.0**
7	Basset Hound	**5.9**	20	Samoyed	**1.6**
8	Doberman Pinscher	**5.5**	21	Dachshund	**1.6**
9	Old Eng Sheepdog	**4.8**	22	Golden Ret	**1.2**
10	Ger Shorthair Pointer	**4.6**	23	Rottweiler	**1.1**
11	Newfoundland	**4.4**	24	Mixed	1.0
12	Ger Shepherd	**4.2**	25	Miniature Poodle	**0.3**
13	Airedale	**4.1**			

Host Risk Factors

Raghavan – JAAHA 42 (1), 2006

- Large breed size
- 170% increase in risk for each unit increase in chest depth/width ratio
- 63% increase in risk assoc with having a first degree relative GDV
- 20% increase in risk for each year increase in age
- 15% increase in risk for each unit increase in speed of eating score
- Nervous temperament

Management Risk Factors
Raghavan – JAAHA 42 (1), 2006

- 110% increase in risk associated with using a raised food bowl
- Feeding once daily
- Feeding a large volume of food per meal
- Feeding dry foods containing fats or oils among the first four label ingredients

Prognostic Indicators

- Published mortality rates range from 10-90%: Mackenzie (10%) – JAAHA 2010; Glickman (24.3%) - JAAHA 1998
- Reported risk factors for increased mortality include…
  - Increased lactate and minimal decrease serially: de Papp - JAVMA 215 (1), 1999; Zacher – JAVMA 236 (8), 2010; Green – JVECC 21 (1), 2011; Beer – JAVMA 242 (1), 2013
  - Gastric necrosis: Matthiesen – VSURG 14(3), 1985; Brockman – JAVMA 207(4), 1995; Brourman – JAVMA 208(11), 1996; Glickman – JAAHA 34, 1998; Zatloukal – ACTA VET. BRNO 74, 2005
  - Splenectomy: Brourman – JAVMA 208(11), 1996; Zatloukal – ACTA VET. BRNO 74, 2005; Mackenzie – JAAHA 46, 2010
  - Partial gastrectomy and splenectomy: Brourman – JAVMA 208(11), 1996; Mackenzie – JAAHA 46, 2010
  - Pre- and post-operative arrhythmia: Brourman – JAVMA 208(11), 1996; Mackenzie – JAAHA 46, 2010
  - Increased duration of clinical signs: Zatloukal – ACTA VET. BRNO 74, 2005
  - Increased high mobility group box 1 and procalcitonin?: Uhrikova – JVECC 25(4), 2015; Troija – Frontiers (5), 2018

Pathophysiology

Gastric Distension

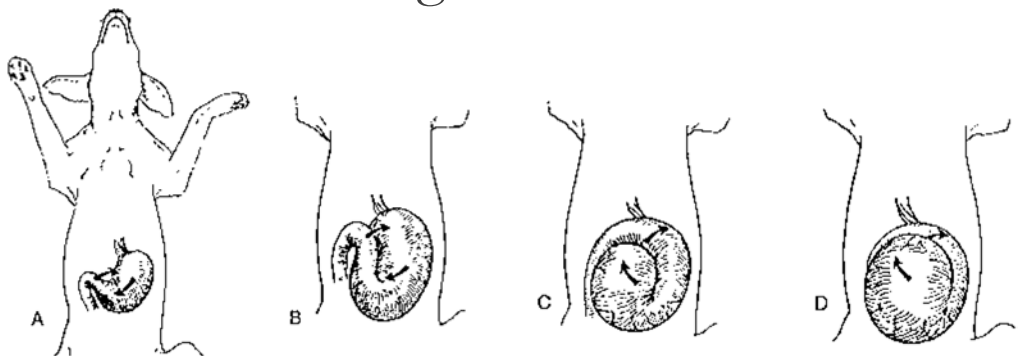
- Caused by swallowing air, fluid, or food
- Results in
  - Decreased venous return to the heart because of compression of the caudal vena cava and portal vein
  - Congestion of splanchnic vessels
  - Increased gastric wall pressure

Sequelae of Gastric Distension

- Decreased venous return
  - Shock
- Congestion of splanchnic vessels
  - Breakdown of the gut mucosal barrier
  - Bacterial translocation (sepsis)
  - Activation of systemic inflammatory mediators (SIRS)
  - Disseminated intravascular coagulation (DIC)
- Increased gastric wall pressure
  - Gastric mucosa ischemia
  - Infarction, ulceration, necrosis, perforation and peritonitis (especially along the greater curvature)

Gastric Volvulus

- When the distended stomach twists on its long axis and occludes the esophageal hiatus and pylorus
- Clockwise rotation is most common (viewed from caudal to cranial with the dog in dorsal recumbency)
- The pylorus and duodenum are displaced ventrally and to the left, across the midline and ending dorsal to the cardia on the left side



Splenic Involvement

- The spleen commonly rotates with the stomach to the right ventral abdomen
  - Gastrosplenic ligaments
  - Short gastric blood vessels
- May lead to
  - Congestion and splenomegaly
  - Splenic infarction and thrombosis
  - Splenic torsion
  - Avulsed gastric branches of the splenic arteries resulting in significant hemoperitoneum

Clinical Signs

- Classic presentation
  - Large, deep-chested dog
  - Acute history agitation and non-productive retching
- Physical exam
  - Distended, tympanic abdomen
  - Ptyalism with thick, ropey saliva
  - Shock

Less Obvious…..

- Can occur in atypical breeds and species
- Distended stomach can be hidden under ribs! (Don't be fooled!)
- Can present in various stages of shock
  - May walk in or present moribund

Diagnosis and Therapy

- Immediate and aggressive stabilization
  - Emergency database
  - Hypovolemic shock
- Confirm diagnosis with radiographs
- Gastric decompression
- Surgery for definitive therapy
- Post-operative monitoring and intensive care

Emergency Database

- QAT's
- Venous blood gas
- Lactate
- Coagulation status

QAT's

- Measures
  - Packed cell volume (PCV)
  - Total protein (TS)
  - Blood glucose (BG)
  - Azotemia estimate (AZO)
- Why?
  - To establish baseline values
  - To aid in monitoring trends

Venous Blood Gas

- Measures
  - Acid base status
  - Electrolyte concentration (Na+, K+, Cl-, Ca2+)
- Why?
  - Decreased venous return results in vascular stasis, lactic acid accumulation, and ultimately metabolic acidosis
  - Compression of the respiratory tract may result in respiratory acidosis
  - Correction of any acid base or electrolyte abnormalities is important prior to induction of general anesthesia

Lactate

- Used to evaluate the adequacy of perfusion
- Produced when anaerobic metabolism occurs and is considered an early indicator of tissue hypoxia
- It should be interpreted in conjunction with clinical perfusion parameters
  - Pulse quality
  - Mucus membrane color
  - Capillary refill time
  - Temperature

Lactate

de Papp - JAVMA 215 (1), 1999

- Retrospective - 102 dogs – overall survival 85%
- 99% of dogs with lactate <6.0 mmol/L survived compared with 58% of dogs with lactate >6.0*
- Low lactate was a better predictor of survival than high lactate was a predictor of death
- Serial measurements are far more useful than a single measurement

Lactate

Zacher – JAVMA 236 (8), 2010

- ✧ Retrospective - 64 dogs – overall survival of 77%
- ✧ Change in lactate before and after initial IVF and decompression
- ✧ Percentage change in lactate concentration was calculated as:

$$\frac{[\text{initial lactate} - \text{postresuscitation lactate}]}{\text{initial lactate}} \times 100$$

- ✧ Exercise caution in applying these results to individual patients….

Variable	Optimal cutoff	Sensitivity	Specificity	Survival rate (%)	
				Value > cutoff	Value ≤ cutoff
Initial lactate concentration (mmol/L)	9.0	0.735	0.733	54 (13/24)*	90 (36/40)
Final lactate concentration (mmol/L)	5.6	0.837	0.800	40 (8/20)*	93 (41/44)
Percentage change in lactate concentration (%)	42.2	0.612	1.000	100 (30/30)*	56 (19/34)

Values in parentheses are number of dogs that survived/number of dogs in the group.
*Within a row, value differs significantly ($P < 0.05$) from the value for survival ≤ cutoff.

Lactate
Green – JVECC 21 (1), 2011

- Retrospective - 84 dogs – overall survival 88%
- Initial plasma lactate > 6.0 mmol/L was not predictive of gastric wall necrosis or survival to discharge
- 70% of dogs whose plasma decreased by ≥ 50% in the initial 12 hours survived to discharge

Lactate / BE

Beer – JAVMA 242 (1), 2013

- Retrospective - 78 dogs, overall survival 83%
- Initial plasma lactate >7.4 mmol/L associated with an increased risk of gastric necrosis and death, however the sensitivity and specificity was relatively poor
  - Gastric necrosis: Sn=50% and Sp=88%
  - Death: Sn=75% and Sp=89%
- Base excess was not useful in predicting either gastric necrosis or outcome

Cell-Free DNA / HMG-B1 / Procalcitonin Troija – Frontiers in Vet. Science (5), 2018

- Prospective – 29 GDV dogs, 24 healthy controls; 76% survival
- GDV dogs had significantly greater median plasma concentrations of cfDNA, HMGB1, and PCT
- A moderate positive correlation was identified between plasma PCT and blood lactate concentrations
- Lactate was predictive of gastric necrosis, unfortunately the degree of overlap between groups precluded identification of a useful cut-off
- PCT was prognostic of non-survival and may offer useful information in these dogs, unfortunately there is currently no commercial POC test

Lactate and GDV Conclusion

- There remains debate about the ideal cutoff for lactate to predict gastric necrosis and survival
- Difficulty prognosticating for the individual patient as there is wide overlap in lactate ranges among survivors and non-survivors, across multiple studies
- The most promising data appears to be in looking at the change in lactate after initial resuscitation

Coagulation Profile
Mills – VSURG 22 (2), 1993

- Prospective – 20 dogs, overall survival 75%
- Parameters evaluated
  - Platelet count
  - PT and PTT (or at the very least an ACT)
  - Fibrinogen
  - Antithrombin
  - Fibrin degradation products or d-dimers
- Findings
  - 7 of 10 dogs with 2 or more abnormal hemostatic test results had gastric necrosis
  - None of the 10 dogs with < 2 abnormal hemostatic test results had gastric necrosis

Shock

- Treat immediately – before diagnostic tests or decompression
- Two large bore, short length, intravenous catheters
  - Cephalic or jugular veins are preferred as they empty into the anterior vena cava
  - Venous return from the caudal portion of the body is impeded
- Bolus to effect
  - Start with 30 ml/kg of isotonic crystalloid
  - Consider
    - **7% Hypertonic saline (4 mL/kg)**
    - Starch (e.g. Hespan, Vetstarch) (10-20 mL/kg)

Intravenous Fluid Therapy

- Allen – VRES 52 (1), 1991
  Schertel – JAVMA 210 (2), 1997
  Beck – JAVMA 229 (12), 2006
- Compared fluid resuscitation with hypertonic saline and synthetic colloids as compared to crystalloids
- Found that hypertonic saline and synthetic colloids
  - Reduced hypotension
  - Improved cardiovascular stability faster, with lesser volumes, and improved oxygen delivery to tissues

Intravenous Fluid Therapy

Haak – JVECC 22 (2), 2012

- Prospective (not blinded) – 20 dogs, overall survival 90%
- Compared polymerized stroma-free Hgb (Hb-200) to 6% hetastarch 450/0.7 in 0.9% saline
  - Patients rec'd 15 mL/kg crystalloid, then randomized into HBOC or HES group
  - Each patient rec'd 5 mL/kg of either HBOC or HES q 10 minutes until resuscitation endpoints were achieved
- Results

	Hb-200	HES
Volume of colloid (mL/kg)	4.2	18.4
Volume of crystalloid (mL/kg)	31.3	48.1
Time for resuscitation (minutes)	12.5	52.5
Adverse effects – mild hypertension	1	1
Mortality	No difference	

- Unfortunately, HBOC's are not currently available
- There continues to be a role for colloids and hypertonic solutions

A Role for Lidocaine?

Bruchim – JVECCS 22 (4), 2012

- Prospective – 130 total dogs, 84.6% overall survival
  - 83 lidocaine treated compared to 47 untreated historical controls
  - Non-controlled
- Lidocaine treatment
  - 2 mg/kg IV loading dose (prior to decompression) followed by 0.05 mg/kg/min x 24 hours
- Results

	Lidocaine	None
Arrhythmia (%)	12	38.3
Creatinine > 2 mg/dL @ 24 hrs (%)	0	3.6
Hospitalization (hours)	48	72

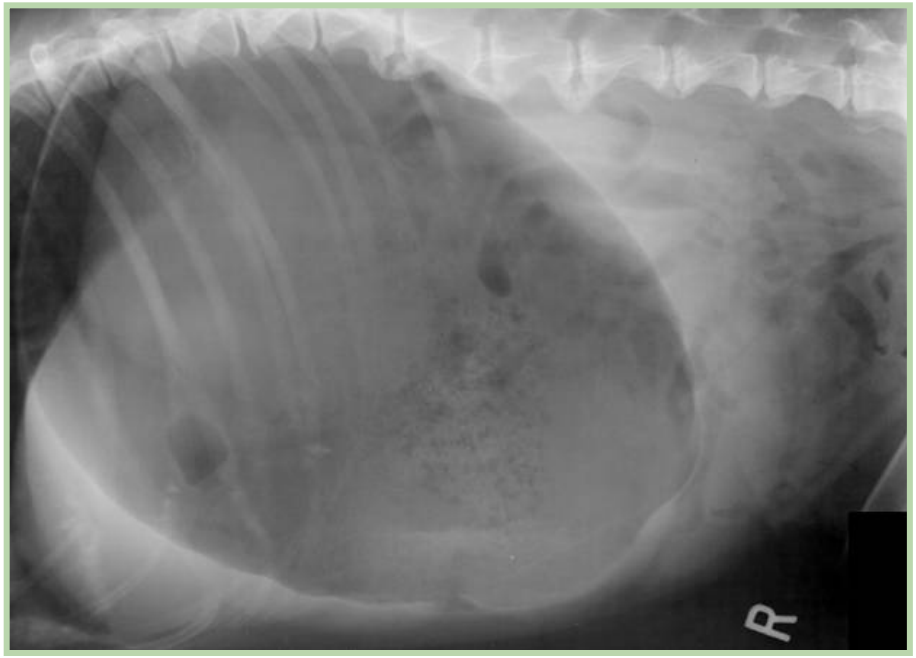
- Lidocaine was safe and might be considered to reduce reperfusion injury and cardiac arrhythmia

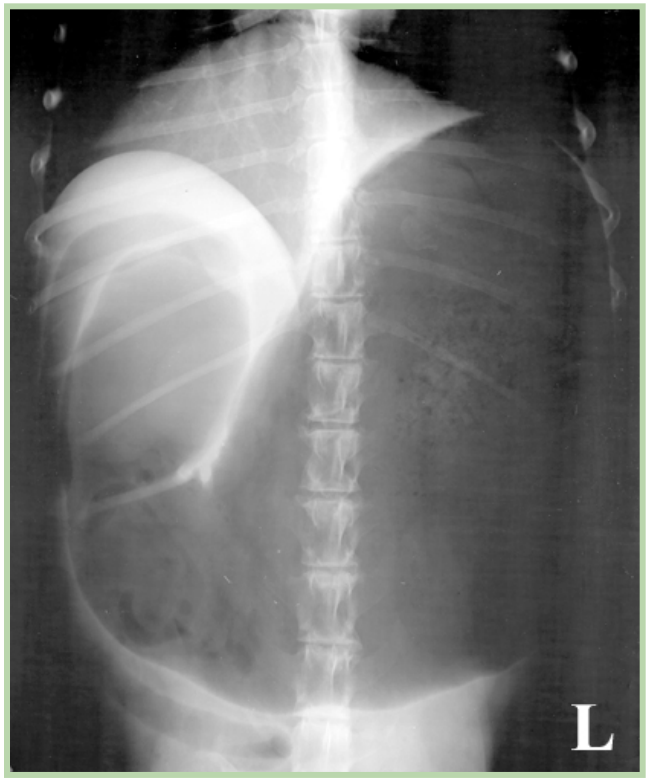
Abdominal Radiographs

- Indicated to differentiate between GDV and gastric distension without torsion
- Views of choice
  - **Right lateral**
  - DV or VD

Gastric Dilation

- The stomach is distended with air and may occupy nearly the entire abdominal cavity

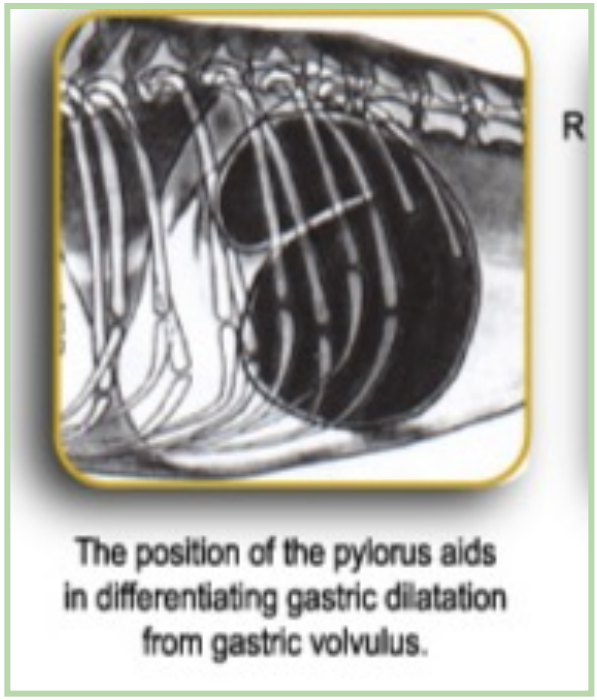


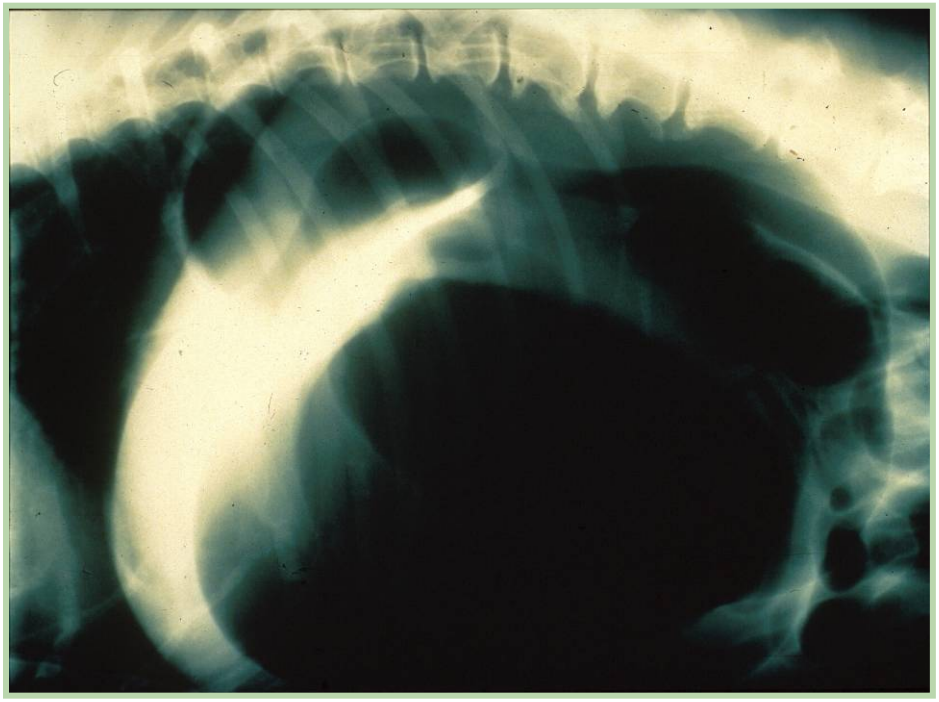


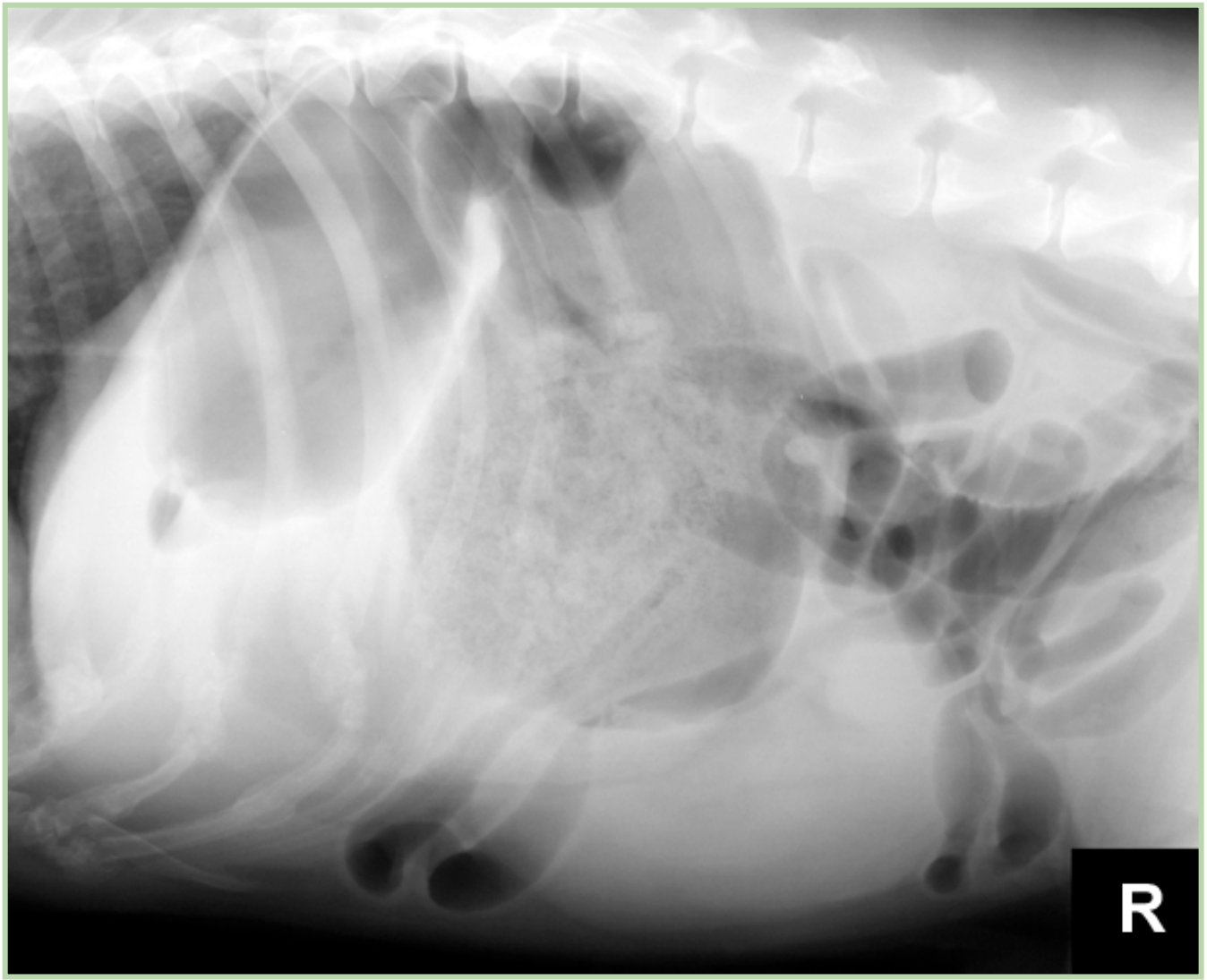
GDV

- Right lateral frequently reveals double bubble gas pattern with compartmentalization signs
- A soft tissue fold can be seen separating the displaced pylorus from the distended fundus with volvulus

Right Lateral Radiograph - GDV



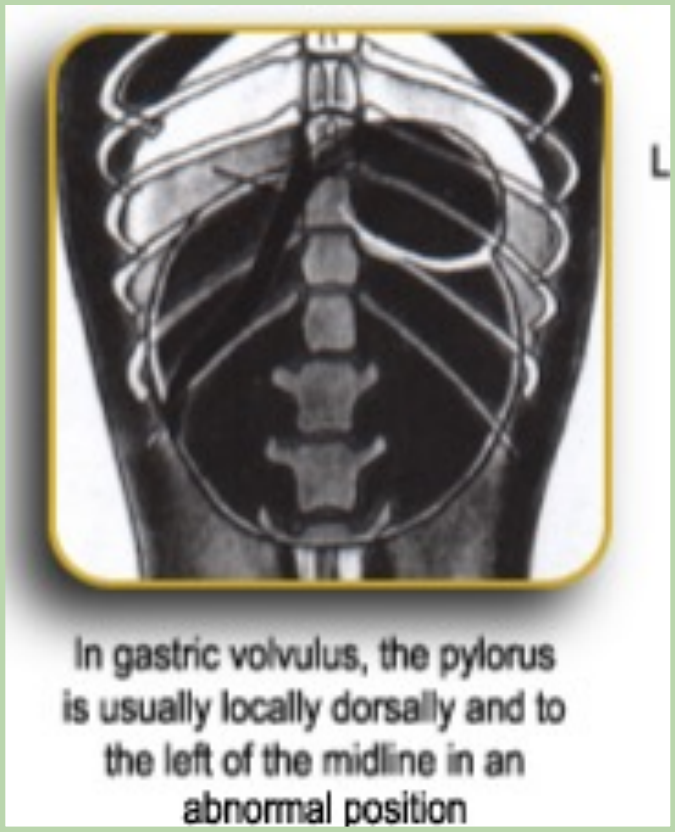




Taylor - 9 yr MI English Setter

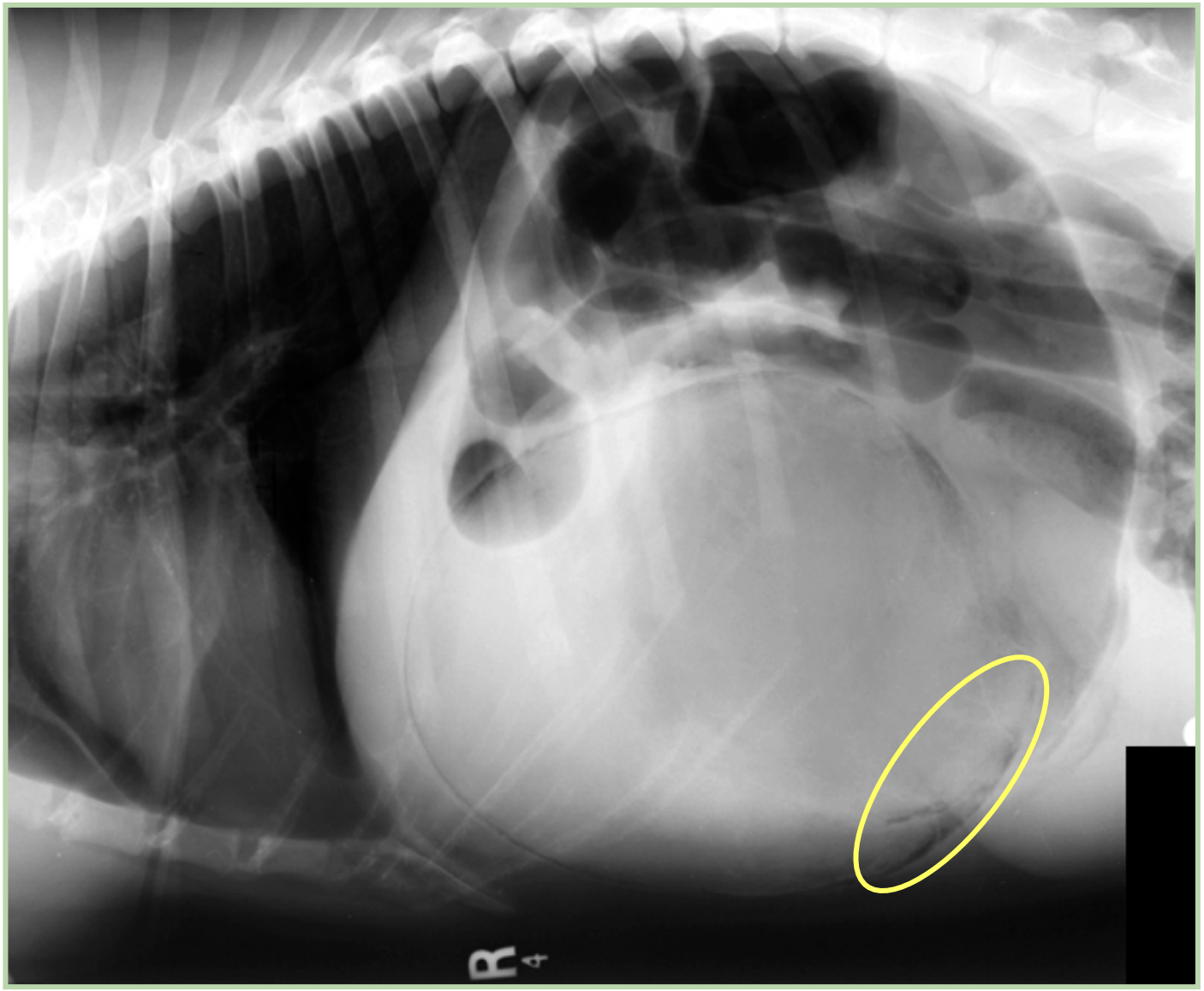
DV or VD View

- GDV - pylorus will be displaced



Other Radiographic Findings
Fischetti – VRAD & US 45 (3), 2004

- Free air in the abdominal cavity
  - Most readily seen between the liver and the diaphragm
  - May indicate gastric necrosis and or stomach rupture
- Gastric pneumotosis
  - Gas dissection of the gastric mucosa
  - May represent gastric necrosis
  - 41% chance dog will require gastric resection as compared to 25% of dogs without gastric pneumotosis



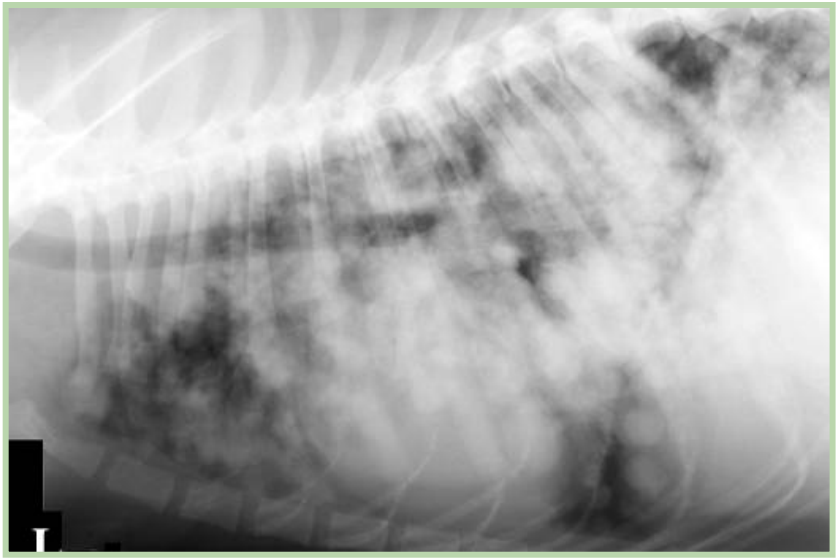
Dickie 7 yr CM German Shepherd

Thoracic Radiographs

Green – JAVMA 22 (5), 2012

- Retrospective – 101 dogs, overall survival 84%
- To determine the incidence of clinically significant findings on TXR in dogs with GDV
- Results

Significant Finding on TXR	%
Small vena cava	40
Esophageal dilation	39
Microcardia	34
Aspiration pneumonia	14
Cardiomegaly*	5
Pulmonary nodule	4
Pulmonary edema	2
Sternal lymphadenopathy	1
Pulmonary bullae	1



- Results support the notion of taking TXR in dogs with GDV, prior to surgery

Gastric Decompression
Goodrich – JSAP 54, 2013

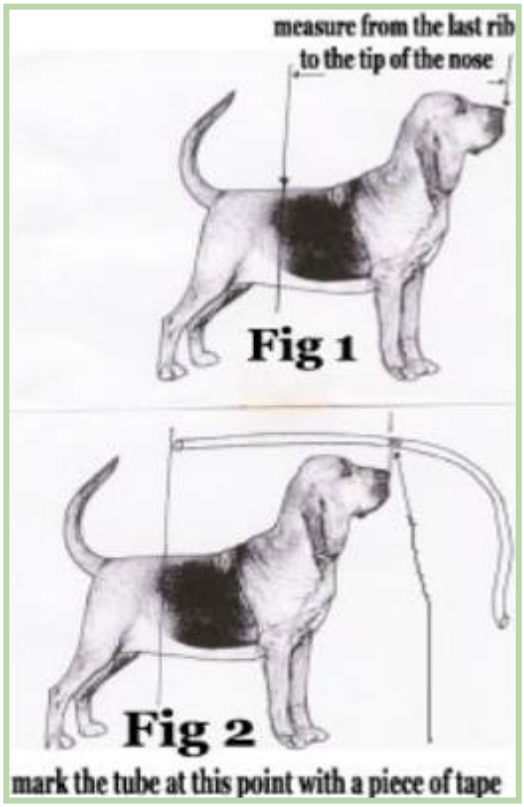
- Retrospective – 116 surgical dogs – survival 95.7%
- Method of decompression (clinician's preference)
  - Orogastric only (sedated) – 31 dogs
  - Trocharization (14g catheter) only – 39
  - Both orogastric and trocharization – 46
- One trocharized dog did have a splenic laceration but did not require splenectomy
- No significant difference between trocharization and orogastric decompression
- Both can be attempted if the previous method fails

Gastric Decompression

- Should not be attempted until after fluid therapy is begun
- Methods
  - Orogastric tube
    - Gastric tube
    - 2 buckets (warm water and efflux)
    - Pump or funnel and water jug
    - 2" role of tape to act as mouth gag
  - Trocharization
    - 14-18g needles or catheters

Orogastric Tube

- Measure from the tip of the nose to the last rib



Orogastric Tube

- ✧ Generously lubricate tube
- ✧ Introduce into mouth and advance into esophagus
- ✧ Palpate tube to ensure it is in the esophagus!

Having Difficulty?

- Avoid excessive force to reduce the risk of perforation
- Gently rotate the tube
- Reposition the patient
  - Elevate the front ½ of the body
  - Place in lateral recumbency
- Trocharize the stomach

Orogastric Tube

- Confirm placement within stomach
  - Rush of sour smelling gastric gas
  - Gastric efflux
- Multiple warm water gastric lavage infusions can be administered to evacuate the stomach

Lavage

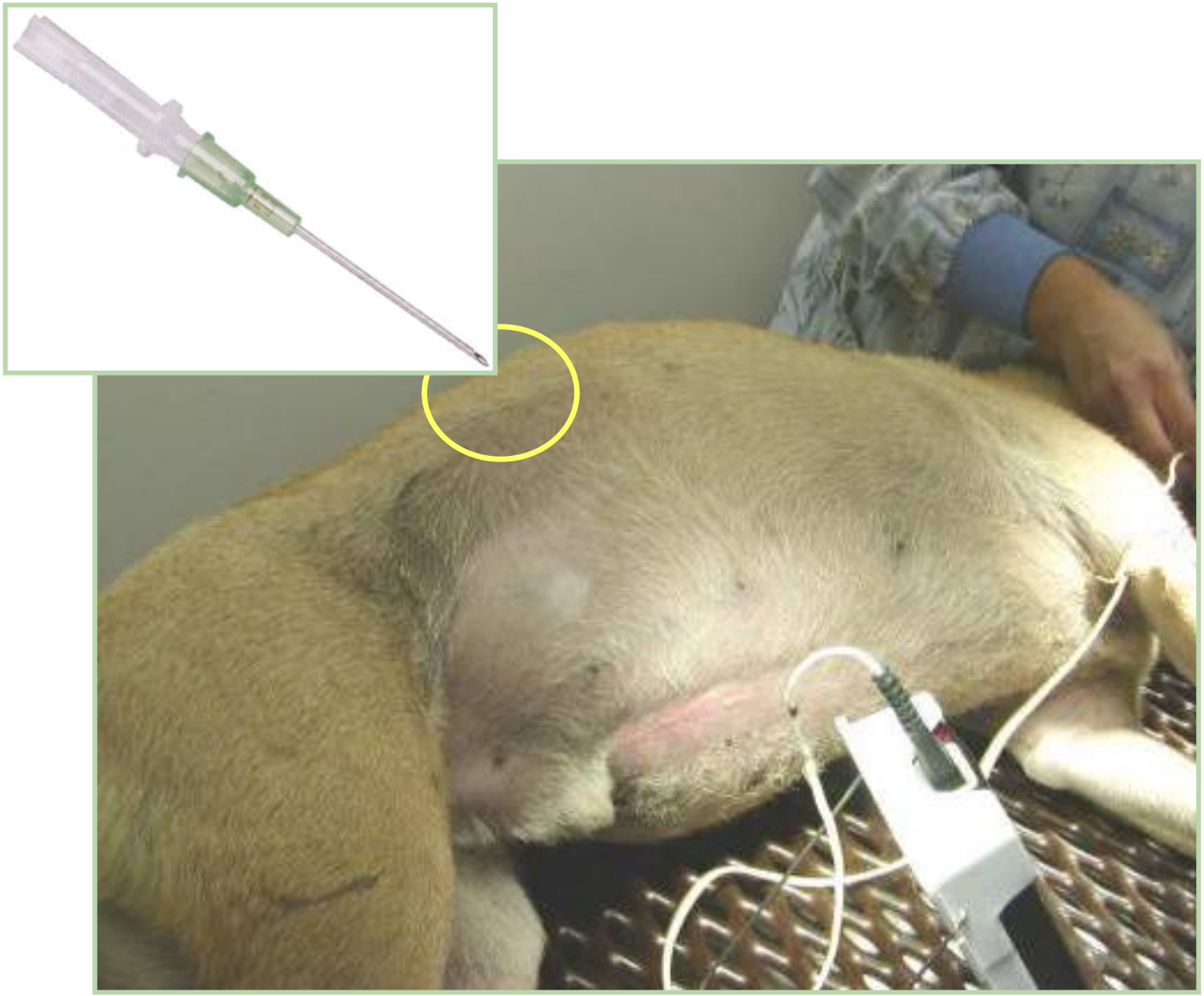
Efflux

Lavage

Efflux

Gastrocentesis / Trocarization

- Clip and aseptically prepare an area behind the last rib at the site of greatest tympany
- Confirm the location by ausculting a "ping" and avoid the spleen
- Use a 16 or 18g needle or catheter as the trocar
- An orogastric tube can usually be passed after a decompression has been achieved



Surgery

- Ideally performed as soon as the patient is hemodynamically stable
- Consider anesthetic protocols that minimize arrhythmogenic potential and hypotension
- Prompt surgery may minimize gastric necrosis and or splenic congestion or thrombosis

Goals of Surgery

- Correct gastric malposition
- Evaluate stomach and spleen for viability
  - Resection of necrotic stomach may be necessary
  - Splenectomy should be performed if perfusion does not return after the stomach is decompressed and repositioned
- Perform gastropexy
  - Multiple techniques are acceptable
  - Reduces recurrence rates from as high as 80% to as low as 3-5%
- Perform a complete exploration of the abdomen

Post-Operative Monitoring

- Vital signs and blood pressure are monitored q 1-4 hours post-operatively
- QAT's, electrolytes and acid-base status should be evaluated 1-4 times daily until the animal is stable
- BUN/creatinine, blood glucose, platelet count and other coagulation parameters are monitored to permit early detection of complications such as sepsis, oliguria (usu due to inadequate fluid therapy), or DIC

Post-Operative Arrhythmia

- Continuous ECG
- Ventricular arrhythmias are common especially 12-36 hours postoperatively
  - Subendocardial necrosis results from decreased cardiac output, mean arterial pressure, and coronary blood flow
  - Usually resolve within 72 hours

Post-Operative Care

- Identify and treat life-threatening complications
- Broad spectrum antibiotics are indicated if sepsis is suspected or gut mucosal barrier is compromised
- Provide analgesia!
- Refeed
  - Food and water are reintroduced 12-24 hours post-operatively

Conclusion

- Gastric dilatation-volvulus is a common surgical emergency and reported mortality rates have decreased significantly over the last twenty years
- Glickman (JAAHA 1998) reported a mortality rate of 24.3%, while today it is closer to 10% (Mackenzie, JAAHA 2010)
- Improved pre-operative stabilization with aggressive and early goal directed therapy is likely the most significant contributing factor to the decrease in mortality
- Continue to watch for peer-reviewed articles!