

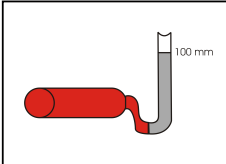
Right Heart Failure: When it's on the Right, don't be Wrong.
 The Causes, Diagnosis and Treatment of Right-sided Heart Failure

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Central Venous Pressure

- Force exerted by the blood against any unit area of the vessel or atrial wall
- Units of pressure
 - mmHg
 - cm water
- 1 mm Hg = 1.36 cm H₂O



Right-sided Congestive Heart Failure usually occurs at >10mmHg (13.6cm of Water)

Signalment

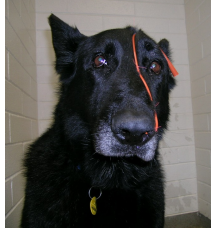
Common Breed Predispositions

- DCM
 - Doberman pinscher, Boxer, Great Dane
- Mitral valve disease
 - Cavalier King Charles Spaniel, Chihuahua, Maltese
- Pulmonary Hypertension
 - West Highland White, Yorkshire Terriers, Pug
- Complete AV Block
 - Cocker spaniels
- Heartworm
 - Any Breed!

*Excellent review:
 Buchanan J.
 Current Vet Therapy XII*

History/Clinical Signs

- Ascites
- Cardiogenic Syncope
 - Exercise Induced
 - Inadequate CO
 - Outflow obstruction
 - Hypoxemia
- Tachypnea
- Cutaneous Edema
- Exercise Intolerance



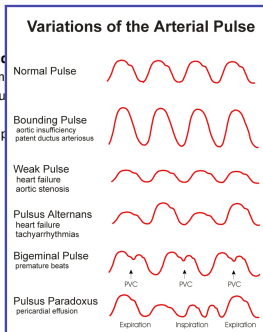
Cardiogenic Collapse

- The family should be questioned about the event.
 - What activity preceded the event?
 - What did the event look like?
 - How long did it last?
 - Describe the recovery
- Knowing the common diseases of the breed often guide our decisions.
 - Large breed dogs with syncope are usually more likely to have ventricular tachycardia
 - Smaller breeds tend to have bradyarrhythmias more commonly.
- Smaller breed syncope is also more commonly non-arrhythmic (Severe MVD or Pulmonary Hypertension)



Cardiovascular Physical Exam

- **Decreased amplitude**
 - Low stroke volume
 - LV outflow obstruction
- **Pulsus Paradoxus** –



Physical Examination

- **RIGHT-sided Murmur**
 - Indicates right-sided disease is likely
 - Specific but not sensitive for presence of disease
 - Loose Indicator of severity of disease
- “False negatives”
 - No murmur, but severe disease.



Physical Examination

- **Jugular Pulse or Distention**
 - Indicates right-sided pressure elevation is likely
 - Specific but not sensitive for presence of disease
- Abdominal Distension
- Cutaneous Edema
- Weak Femoral Pulse



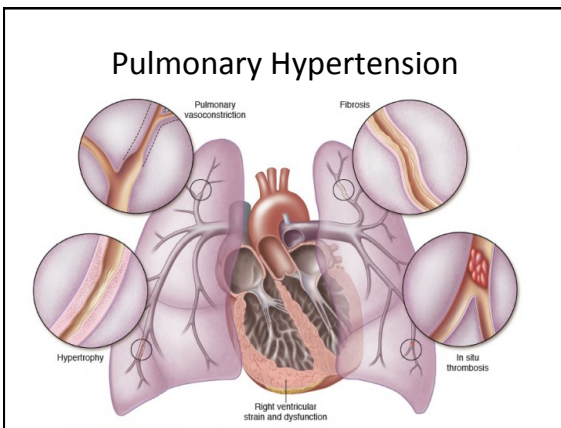
Characteristics of The Pulmonary Circulation

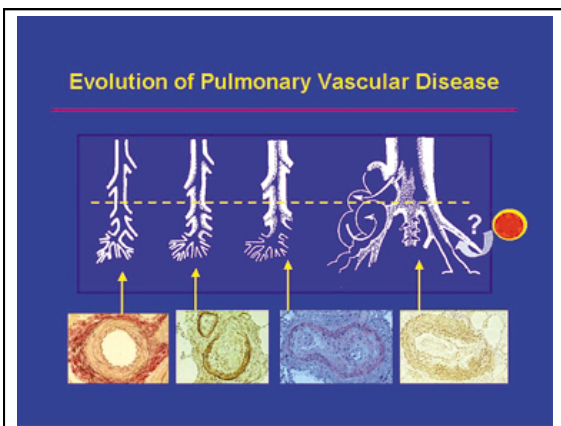
- Low pressure, Low resistance circuit
 - Vasoconstriction in response to hypoxia is the fundamental difference of pulmonary blood vessels compared to systemic vessels.
 - This is due to Hypoxic Pulmonary Vasoconstriction (HVP), Still a poorly elucidated reflex.
 - Constriction of the small arterioles occurs within a few seconds of reduced oxygen concentration and peaks between 2-4 hours after the onset of hypoxia.

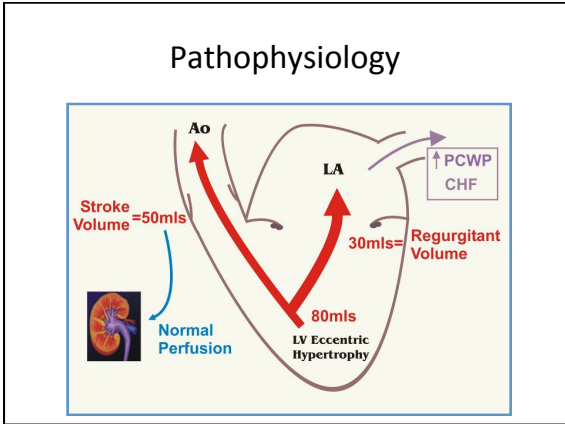


Pulmonary Hypertension

- **Causes of Pulmonary Arterial Hypertension (PAH)**
 - Primary Pulmonary Disorders
 - Chronic Left Heart Disease (Pulm. Venous Hypertension)
 - Heartworm Disease
 - Pulmonary embolism or in-situ thrombosis
 - Primary pulmonary hypertension
 - Congenital systemic-to-pulmonary shunt
 - Portopulmonary hypertension (Thought to be related to increased levels of Endothelin-1.

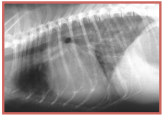







- ### Keys to Evaluation
- *History of aggravating morbidities*
 - *Presence of Physical Examination Abnormalities*
 - *Heart size*
 - Reflects level of neurohormonal activation
 - Reflects severity of disease
 - *Pulmonary artery pressures*
 - Reflects risk of morbidity and mortality
 - *Response to Therapy*
 - Can help determine underlying cause
- 

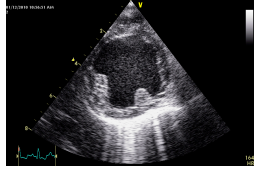
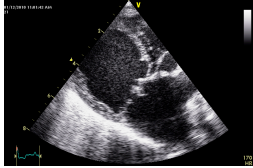
What info do I need next?

- Thoracic Radiography 
- Echocardiography 

Diagnose The Disease

Echocardiography is the "Gold Standard" for Diagnosis of Structural Cardiac Disease

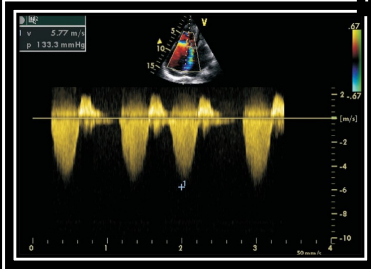
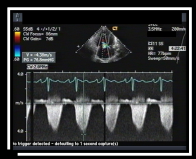
•Assess systolic and diastolic function.



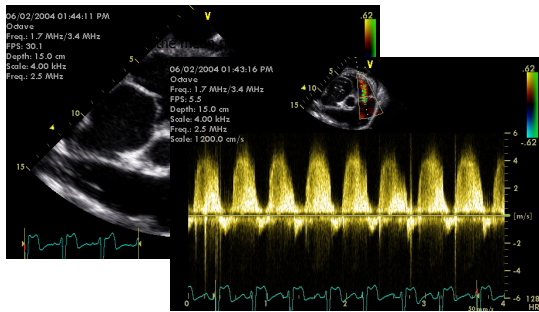
•Best noninvasive assessment of pulmonary artery pressures, left atrial and right ventricular pressures.
•Can also help assess systemic blood pressure and "White Coat Syndrome"

Pulmonary Hypertension

The Vmax of the tricuspid insufficiency jet approximates the systolic pulmonary artery pressure.

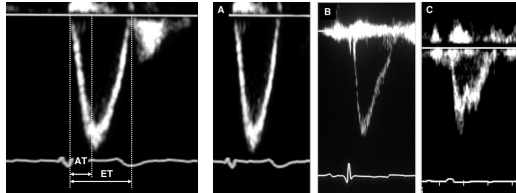


Pulmonary Hypertension



Pulmonary Hypertension

■ Right Ventricular Acceleration and Ejection Time



Schober K, Baade H. J Vet Intern Med 2006;20:912-920

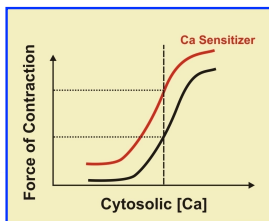
Sildenafil



- Sildenafil is a type V phosphodiesterase inhibitor that produces nitric oxide mediated vasodilatation of the pulmonary vasculature.
- Rapid onset: Within 15 min. and peak effect at 2 hours. Half Life is 4 hours.
- This drug class can slightly reduce arterial systemic blood pressure, but is one of the most selective for the pulmonary vasculature.

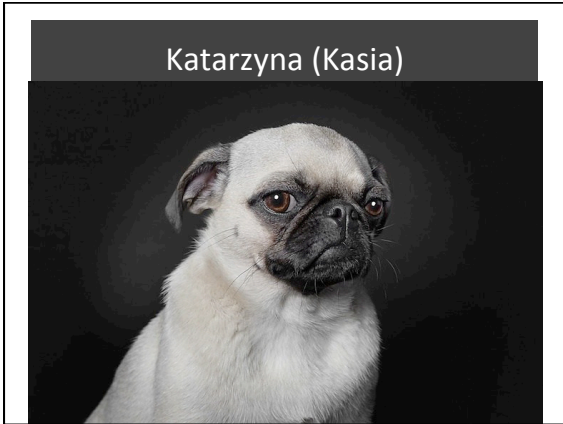
Pimobendan

vetedin
(pimobendan)



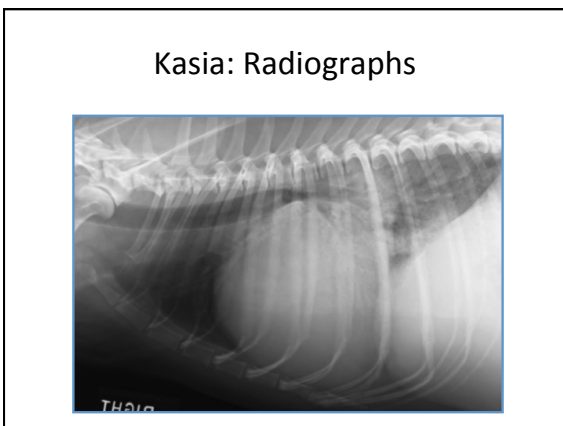
- Inodilation:
Calcium Sensitizer
PDE III Inhibitor
PDE V Inhibitor
Same mechanism as Viagra

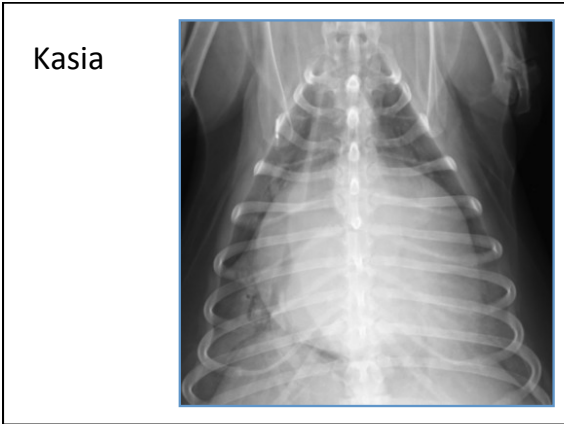


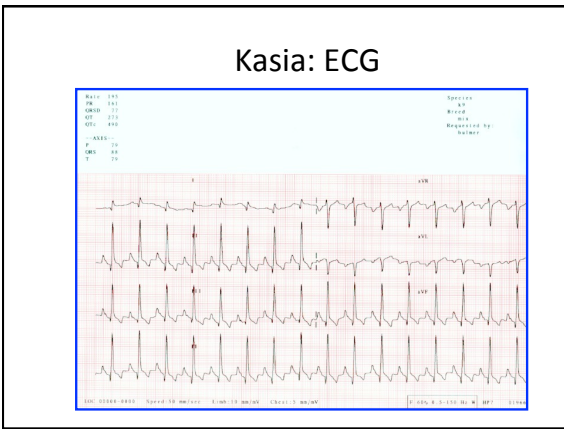


Katarzyna (Kasia)

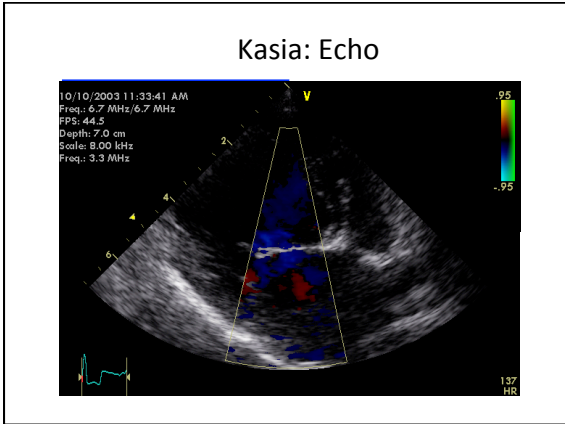
- 10-yr old, FS Pug presents to your hospital for a reduced appetite for the last 3 days, recent lethargy, progressive abdominal distention, and a single episode of collapse that occurred this morning, history of severe, asymptomatic mitral disease. Not currently on any medications
- IV/VI left and right apical systolic murmur
- Regular heart rhythm
- Normal lung sounds

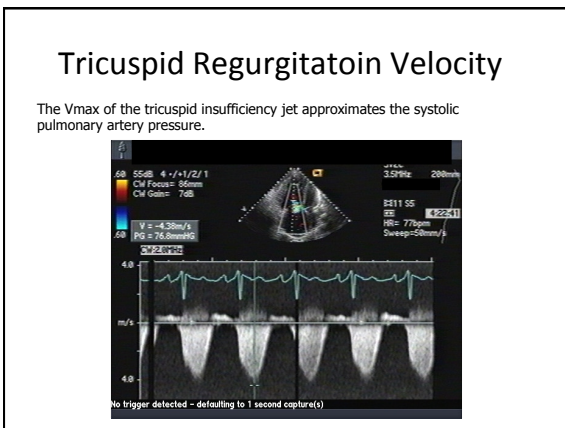






- Kasia: Additional Rhythm Diagnostics
- Limitations of in-hospital ECG and HR measurement
 - 24-hour ambulatory (Holter) monitoring






DVD CHF and Pulmonary Hypertension

KASIA: 10yr old, FS, Pug

- An echocardiogram reveals severe degenerative valve disease with moderate pulmonary hypertension. Moderate to severe volume ascites. The ECG shows sinus rhythm. Normal systolic function with severe left-sided and modest right-sided cardiomegally. Mitral inflows are consistent with left atrial pressures >20mmHg.
- Right-sided Congestive Heart Failure.**



Question

- What should we do first?
- What Chronic Therapy Prescribed
- What type of follow-up

Treatment of Right Heart Failure



If you can take it out with a needle, what are you waiting for?




Kasia: DVD, CHF, PHT Chronic Treatment

Recommended Medications:
The LIV Protocol
Triple therapy

- L**asix (~2 mg/kg/day)
- A**CE Inhibitor (Enalapril 0.5 mg/kg BID)
- V**etmedin (Pimobendan 0.3 mg/kg BID)

Pulmonary Hypertension Treatment

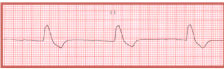
- Chronic Treatment:
 - Sildenafil
 - Vetmedin
 - Heparin or LMWH
 - L-Arginine (NOS converts to NO)
 - Amlodipine
 - Heartworm Treatment
 - ACE Inhibitors
 - Diuretics



Bradyarrhythmias

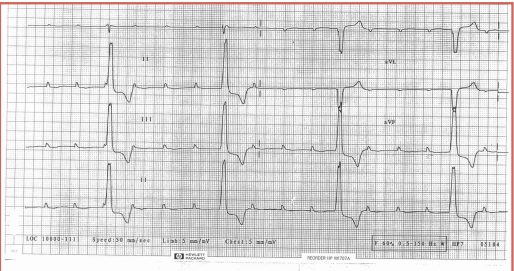
These patients die suddenly or if they live long enough, they go into right heart failure.

- Stimulants used: Theophylline, Propranolol.
- Artificially pace them as soon as possible.



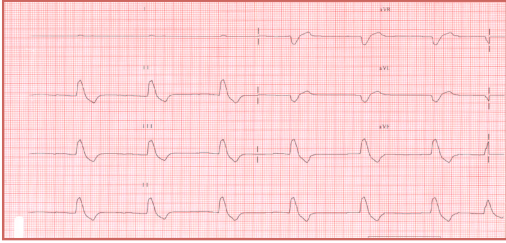
ECG

Complete AV Block



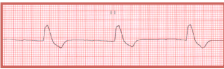
ECG

Atrial Standstill



Treatment of Arrhythmias

- **Stimulants used: Theophylline, Propranolol.**
- **Artificially pace them as soon as possible.**
- **"LIV Protocol" in Heart Failure Patients**
- **Poor Prognosis without pacing.**



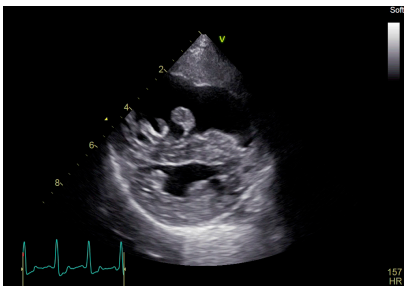
Snowy: 3 yr, FS, Shepherd Mix



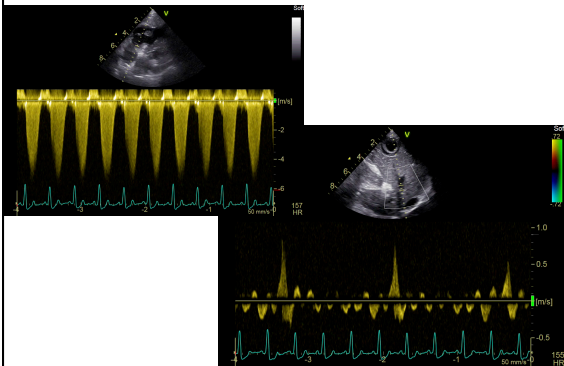
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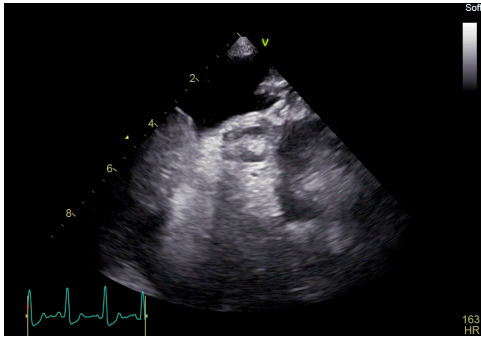
Snowy: 3 yr, FS, Shepherd Mix



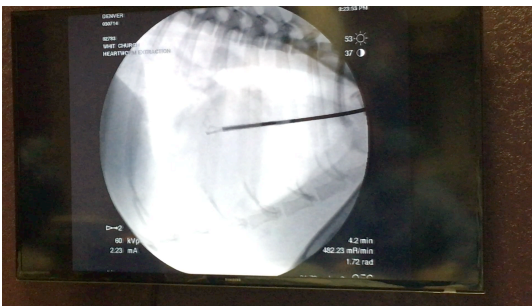
Snowy: 3 yr, FS, Shepherd Mix



Snowy: 3 yr, FS, Shepherd Mix



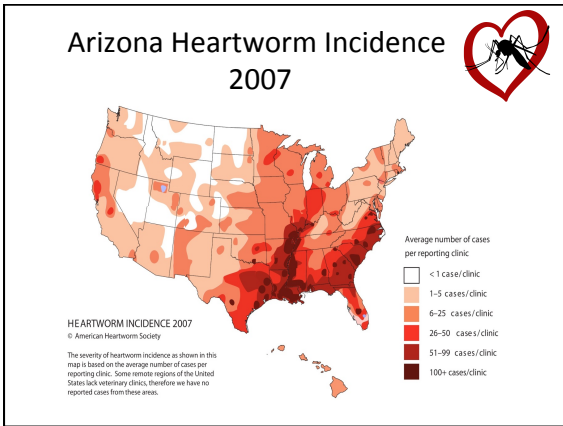
Snowy: 3 yr, FS, Shepherd Mix

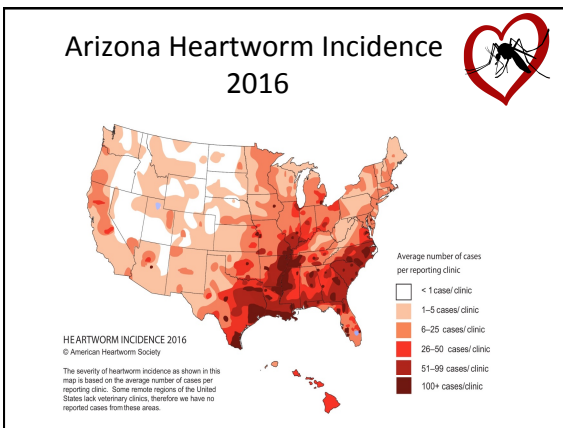


Heartworm in Arizona



- There are consistently more cases of heart worm diagnosed in Arizona each year. The maps below show the increase in reported cases in USA in 2007 and 2016. Take note of the increased color density of Maricopa and Pima counties.





Heartworm Treatment

- If the dog is symptomatic:
 - Stabilize with appropriate therapy and nursing care
 - Prednisone therapy should be used as an immediate antiinflammatory for the arteritis, pneumonitis, and to relieve symptoms associated with thromboembolism.
- An ivermectin based heartworm preventative should be administered for 60 days prior to Melarsomine.
- Doxycycline (10 mg/kg BID for 4 weeks) should be administered for 60 days prior to Melarsomine. Benefits the patient by killing the Wolbachia bacteria species in the gastrointestinal tract of the dirofilaria immitis parasite which may be partially responsible for the severe inflammatory reaction to the heartworm parasite, and allowing a 30 day “wash out” period for Wolbachia Surface Proteins
- Conservative (3 Dose) melarsomine (Immiticide) protocol.

Heartworm Treatment

Conservative (3 Dose) melarsomine (Immiticide) protocol.

1. One 2.5mg/kg deep epaxial muscle injection followed by 4 weeks of confinement with no exercise other than outside to use the restroom.
2. A second 2.5mg/kg dose of melarsomine via deep epaxial muscle injection should be given.
3. 24 hours later a third deep epaxial muscle 2.5mg/kg injection of melarsomine should be administered. This makes a total of 3 injections, one dose, wait 4 weeks, and then 2 doses 24 hours apart. After the final dose of melarsomine, the patient must be confined for an additional 4 weeks.
4. Monthly ivermectin based heartworm prevention and Prednisone should be continued throughout the melarsomine treatment.
5. Adulticide therapy can be associated with complications that include respiratory distress, anemia, ascites, cyanosis, kidney or liver failure, and sudden death.
6. The cardiac and pulmonary changes may be a persistent problem despite resolution of the active heartworm infection, but most dogs can return to an asymptomatic form of pulmonary hypertension and inactive pneumonitis.

Heartworm Treatment


Conservative (3 Dose) melarsomine (Immiticide) protocol.

- Retest antigen and for microfilaria in 6 months!

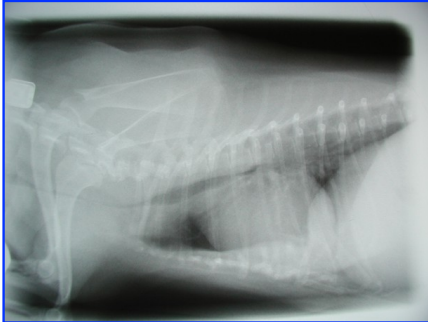


Leo : 10yr old MN Pom

- Family complaint of labored, noisy breathing with any degree of excitement, and often occurs at rest as well. After being asked, the owners admit to a chronic cough over the last 6 years that always occurred with excitement.
- Grade II/VI right apical Systolic murmur
- Mildly tachycardic (HR=160)
- Referred upper airway noise
- Normal pulse strength and Mild jugular distention
- Loud noise with each expiration
- Current medications: None



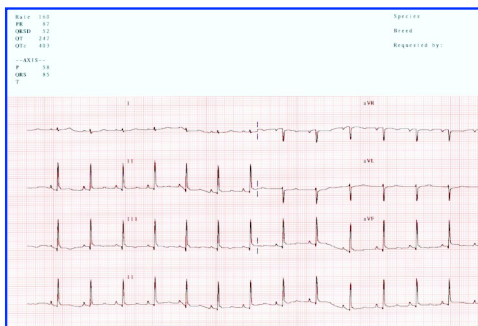
Leo's Radiographs



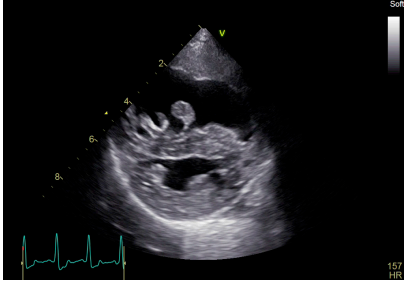
Leo's Radiographs



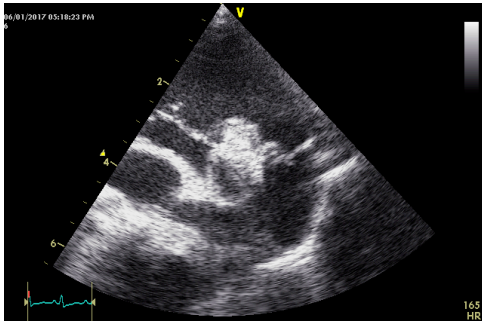
Leo's ECG



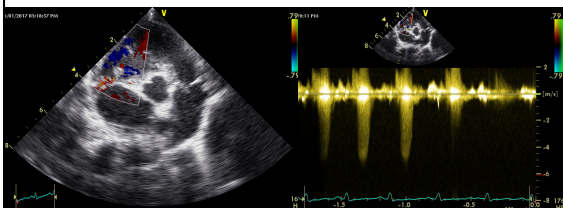
Leo: Echocardiogram

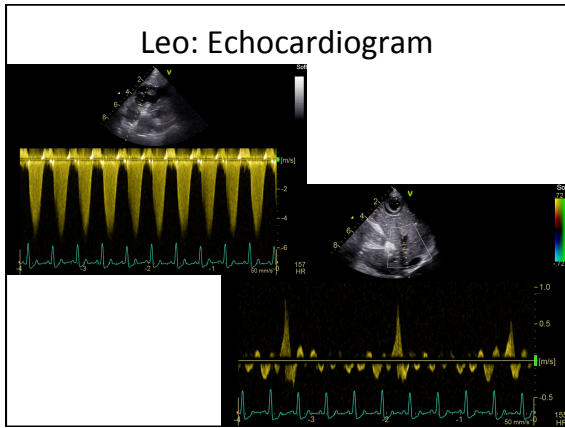


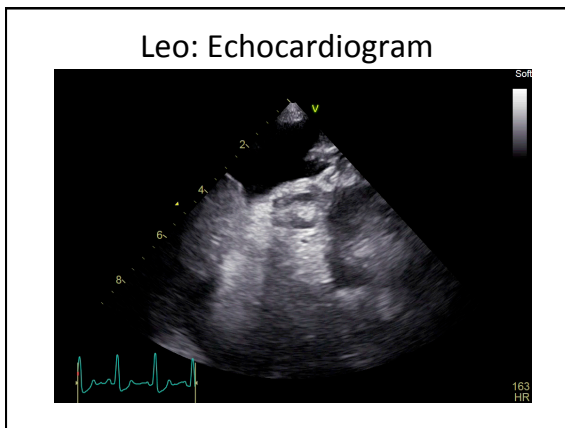
Leo's Echo

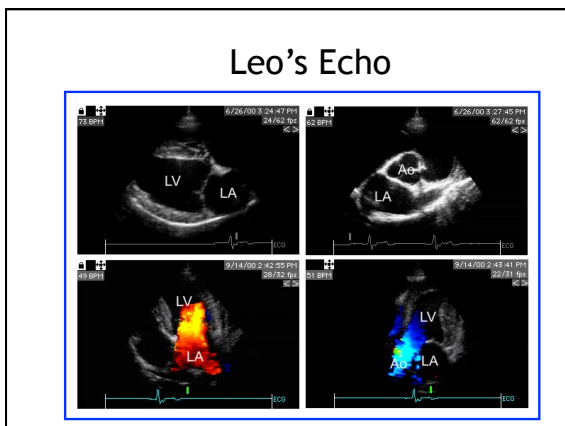


Leo's Echo









Question

- What treatment protocol should be start:
- LIV
- Antibiotics
- Sildenafil
- Cough Suppression and Steroids

Leo

- **Radiographic interpretation:** Severe tracheal collapse with mild atelectasis in the caudal lung fields on the lateral view. Cardiac silhouette appears enlarged, with suspected right heart enlargement. Pulmonary vasculature is not well visualized, but does appear within normal limits.
- **Echocardiophic Interpretation:**
Patient has mild degenerative valve disease, but the heart enlargement is due to severe pulmonary hypertension TR PG=98mmHg. Patient also has mild ascites.
 - Recommended medications:
 - Sildenafil 1-2mg/kg BID-TID
 - LIV






Leo's Additional Treatments

- 1 Hydrocodone 0.5mg/kg BID to TID as needed for cough.
- 2 If cough does not improve: Prednisone 0.25mg/kg BID tapering dose over 3 weeks.
- 3 Consider Bronchodilators: Theophylline
- 4 Weight Loss
- 5 Environmental Control
- 6 Harness

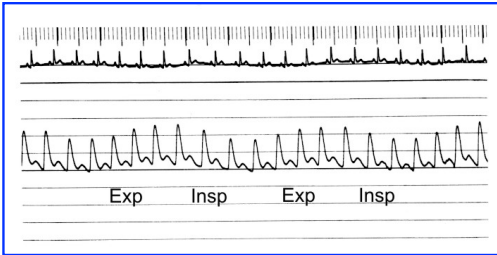
Teton

8yr old, MN, Bernese Mountain Dog



- Presents with a complaint of panting, weakness, anxiousness, inappetance, and abdominal distention.
- HR=140/min with a regular rhythm
- Weak and variable femoral pulses
- No cardiac murmur, but a jugular pulse is present.


Teton: Arterial Pulse Tracing




Exp Insp Exp Insp

Question

- Pulsus paradoxus is almost pathognomonic for which cardiovascular problem:
- DCM
- Valvular heart disease
- Heartworm disease
- Pericardial effusion


 **Teton**

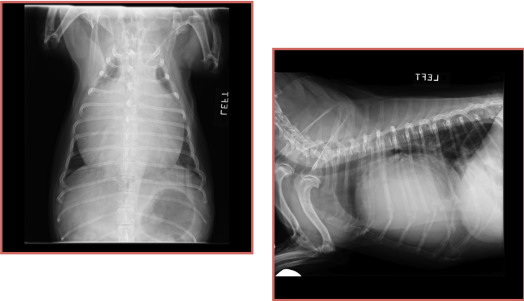
Lead II Rhythm Strip



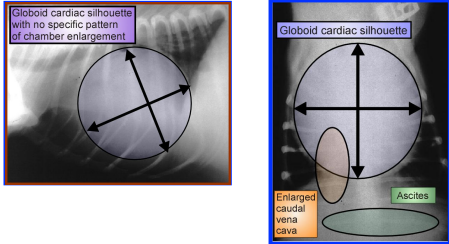
Question

- Was the ECG Helpful?
- Yes
- No

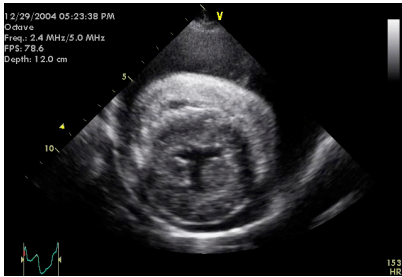
 **Teton's Radiographs**



Radiographic Findings

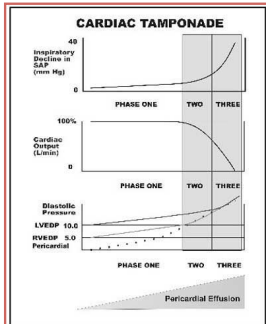
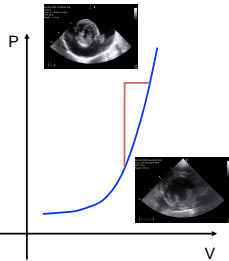


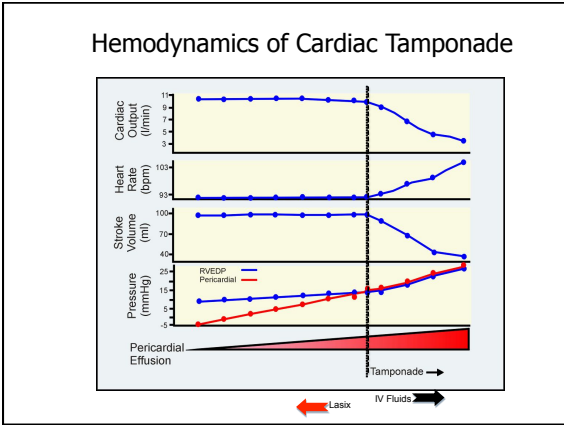
Teton's: Echocardiogram




Treatment of Cardiac tamponade

Cardiac tamponade





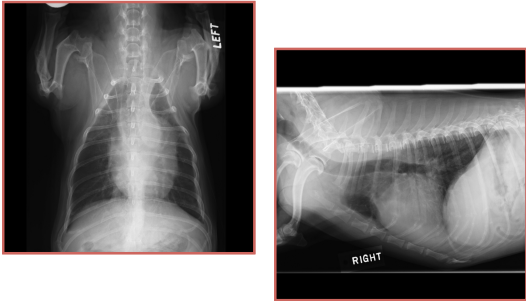



Teton

5yr old, MN, Bernese Mountain Dog

- Pericardial effusion Confirmed with Echocardiography
 - 350ml of hemorrhagic fluid removed via pericardiocentesis.

Treatment of Cardiac Tamponade




 **Teton's Diagnosis**

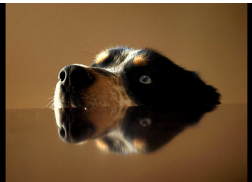
LOCATION=Ao vs. RA

CYTOLOGY=

FNA=



SX=DIAGNOSIS
PERICARDIECTOMY

 **Teton**

5yr old, MN, Bernese Mountain Dog

- No mass lesion, but one area of pericardial adhesion seen on echocardiogram.
- Check Valley Fever Titers.
- Consider Pericardiectomy.

Questions?