Practical steps to diagnose and effectively manage canine heart failure

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Major Causes- Canine Heart Disease

- 90% Chronic Myxomatous Valvular Disease
- 5-7% Cardiomyopathy (DCM, ARVC)
- ~3 % Arrhythmias (Afib, VT); PS, PDA

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Major Causes of Heart Disease

- 85% HCM
- 15% LV Remodeling
- RCM, DCM, ARVC
- Arrhythmias; Myocarditis

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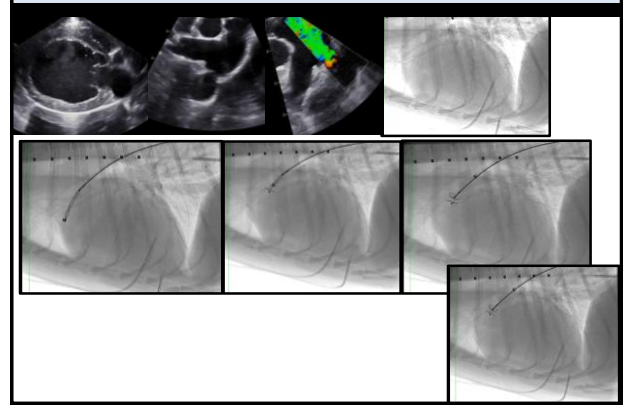
Congen. Heart Disease Emergencies- PDA



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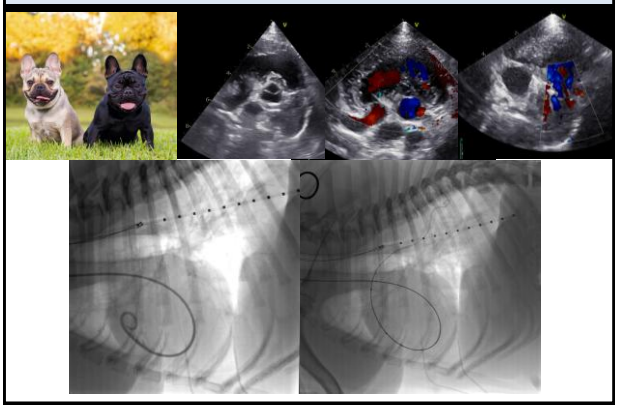
Congen. Heart Disease Emergencies- PS



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Chronic Myxomatous Valvular Heart Disease (MMVD)

A. What is MMVD?
B. Prevalence?
C. Morbidity / mortality?
D. How to diagnose and *stage* MMVD?
E. How to identify CHF?
F. Best strategies to manage each stage?

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Chronic Myxomatous Valvular Heart Disease (MMVD)

Journal of Veterinary Internal Medicine Open Access

ACVIM consensus guidelines for the diagnosis and treatment of myxomatous mitral valve disease in dogs

Bruce W. Keene,[R 1] Clarke E. Atkins,[1] John D. Bonagura,[1,2] Philip R. Fox,[3] Jens Häggström,[4] Virginia Luis Fuentes,[5] Mark A. Oyama,[6] John E. Rush,[7] Rebecca Stepien,[8] and Masami Uechi[9]

Heart Disease Prevalence: **10%** of dogs presenting to primary care practices

MMVD = 75% of canine heart disease

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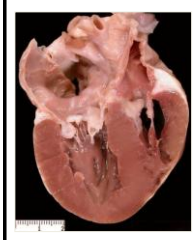
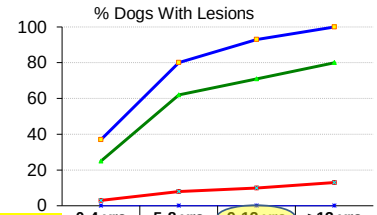


Whitney J. *J Small Anim Pract* 1974;15:511

Necropsy Prevalence (%)
Myxomatous Valve Degeneration
by Age Quartile



Age (years)	0-4 yrs	5-8 yrs	9-12 yrs	>13 yrs
Mitral	37	80	93	100
Tricuspid	25	62	71	80
Aortic	3	8	10	13
Pulmonic	0	0	0	0

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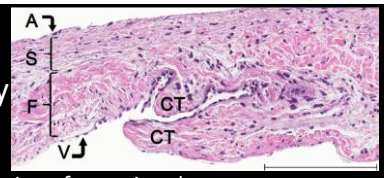
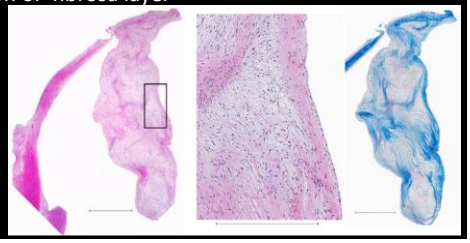
MMVD Histopathology



Continuum!

- Progressive expansion of spongiosa layer
- Disruption of fibrosa layer

ALTERS TENSILE AND COMPRESSIVE STRENGTH



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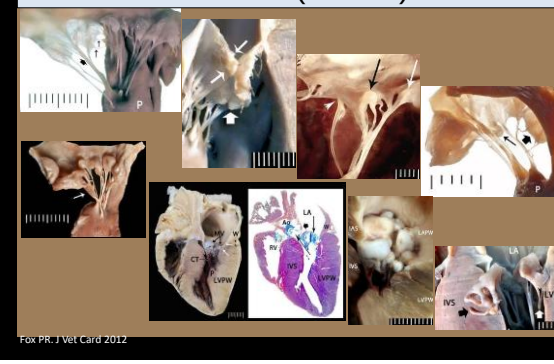
Chronic Myxomatous Valvular Heart Disease (MMVD)



Fox PR. J Vet Card 2012

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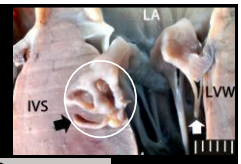
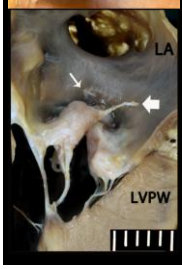


MMVD **Chordae Tendineae Rupture**



Chorda distend, taper at mid portion

- CT are larger, heavier,
- Fail at lower tensile stress

Ruptured CT =marginal CT

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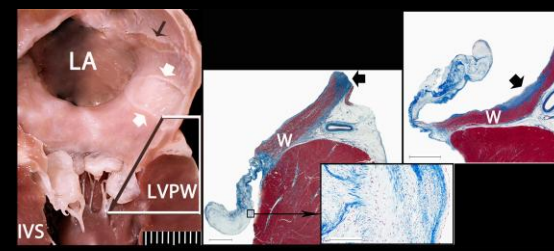
Myxomatous Mitral Valvular Disease **LA Tear & Rupture**



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Survival Time- Dogs with Advanced Heart Failure (MMVD)

J Vet Intern Med. 2018 May-Jun; 32(3): 944–950.
Journal of Veterinary Internal Medicine Open Access

Clinical findings and survival time in dogs with advanced heart failure

Amelie Beaumier, [1] John E. Rush, [1] Vicky K. Yang, [1] and Lisa M. Freeman [1]

- Advanced CHF- Median survival: 281 days (approx. 9 months) [range, 3-885 days]
  - Rx furosemide >6.7 mg/kg/day had significantly longer median survival (402 days [range, 3-885 days] vs 129 days [range 9-853 days]; P = .017).

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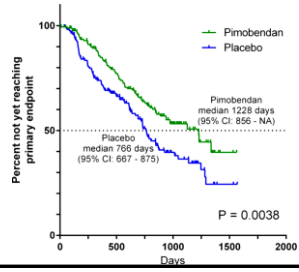
J Vet Intern Med 2016;30:1765–1779

Effect of Pimobendan in Dogs with Preclinical Myxomatous Mitral Valve Disease and Cardiomegaly: The EPIC Study—A Randomized Clinical Trial

A. Boswood, J. Häggström, S.G. Gordon, G. Wess, R.L. Stepien, M.A. Oyama, B.W. Keene, J. Bonagura, K.A. MacDonald, M. Patteson, S. Smith, P.R. Fox, K. Sanderson, R. Woolley, V. Szatmári, P. Menaut, W.M. Church, M. L. O'Sullivan, J.-P. Jaudon, J.-G. Kresken, J. Rush, K.A. Barrett, S.L. Rosenthal, A.B. Saunders, I. Ljungvall, M. Deinert, E. Bomassi, A.H. Estrada, M.J. Fernandez Del Palacio, N.S. Moise, J.A. Abbott, Y. Fujii, A. Spier, M.W. Luethy, R.A. Santilli, M. Uechi, A. Tidholm, and P. Watson



Criteria to Administer Pimobendan

- LA:Ao ≥1.6
- VHS > 10.5
- LVDd normalized ≥1.7

Median time to CHF:
P+ 3.4 yr
P- 2.1 yr
+ 15.5 mo. benefit

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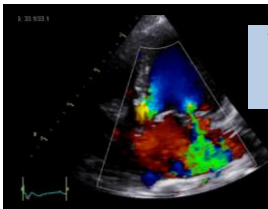

What is the Financial Burden of MMVD?

$1500 - $5500/yr
Insurance 'precondition'
Albatross for elective Sx

Medical Visits	($150 x 2	$ 300
Echo Exams	($700 x 2	$1400
Chest Rads	($300 x 1	$ 300
Blood Tests	($220 x 1	$ 220
ECG	($100 x 1	$ 100
Rx (Vetmedin + Lasix +…)		$ 750-3500

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How to Classify Dogs with MMVD
(Dogs advance from 1 stage to the next)

		Structural heart disease (MR murmur, thick MVs, other pathology)		*Current or Previous* ***CHF, Clinical signs***	
Disease Stage	*A* *High Risk* to develop disease	***B1*** *Mild to mod. LAE: no Rx*	***B2*** Advanced Vetmedin Subset	***C***	***D***
Remodeling	None	+/-	Mod	Severe	End-stage
Symptoms	No	No	No	CHF current / past	Refractory to Drugs
X-Ray/ Echo Changes	No	No	Mild-mod LAE, LVE	Severe LAE; LVE	Severe LAE; LVE

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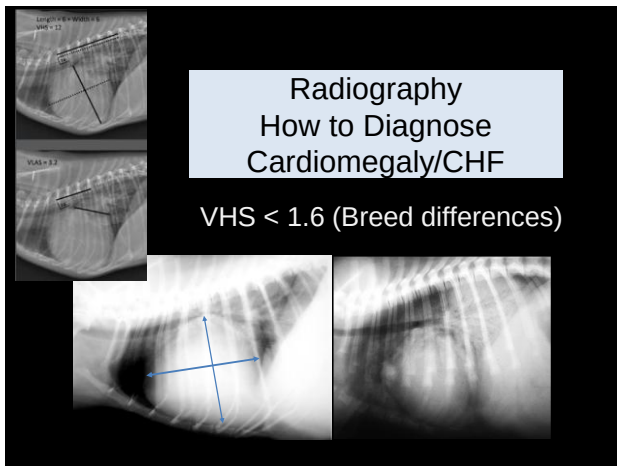

Radiography How to Diagnose Cardiomegaly/CHF

VHS < 1.6 (Breed differences)

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Vertebral Heart Scale Breed Variability!

DOG BREED	RECUMBENCY	VHS±S.D	NORMAL RANGE	REFERENCE
Various	**Left/Right**	9.5±0.5	**8.7-10.7v**	**Buchanan & Bucheler (1995)**
American Pit Bull Terrier	Right	10.9±0.4	10.1-11.7	Lahm et al. (2011)
Beagle	Left	10.2±0.4	9.4-11.0	Kraetschmer et al. (2008)
Beagle	Right	10.5±0.4	9.7-11.3	Kraetschmer et al. (2008)
Boston Terrier	Right	11.7±1.4	8.9-14.5	Jepsen-Grant et al. (2013)
Boxer	Right	11.6±0.8	10.0-13.2	Lamb et al. (2002)
Bulldog	Right	12.7±1.7	9.3-16.1	Jepsen-Grant et al. (2013)
Cavalier King Charles Spaniel	Right	10.6±0.5	9.6-11.6	Lamb et al. (2001)
Dachshund	Right	9.7±0.5	8.7-10.7	Jepsen-Grant et al. (2013)
Doberman	Right	10.0±0.6	8.8-11.2	Lamb et al. (2002)
German shepherd	Right	9.7±0.8	8.1-11.3	Lamb et al. (2001)
Greyhound	Left/Right	10.5±0.1	10.3-10.7	Marin et al. (2007)
Labrador Retriever	Left	10.29±0.04	10.2-10.4	Gugjoo et al. (2013)
Labrador Retriever	Right	10.39±0.05	10.3-10.5	Jepsen-Grant et al. (2013)
Lhasa Apso	Right	9.6±0.8	8.0-11.2	Jepsen-Grant et al. (2013)
Pomeranian	Right	10.5±0.9	8.7-12.3	Jepsen-Grant et al. (2013)
Poodle	Right	10.12±0.51	9.1-11.1	Fonsecapinto & Iwasaki (2004)
Pug	Right	10.7±0.9	8.9-12.5	Jepsen-Grant et al. (2013)
Rottweiler	Left/Right	9.8±0.1	9.6-10.0	Marin et al. (2007)
Shih Tzu	Right	9.5±0.6	8.3-10.7	Jepsen-Grant et al. (2013)
Turkish Shepherd	Left	9.7±0.67	8.4-11.0	Gulanber et al. (2005)
Whippets (Racing pedigree)	Left	11.1±0.4	10.3-11.9	Bavegems et al. (2005)
Whippets (Racing pedigree)	Right	11.4±0.4	10.6-12.2	Bavegems et al. (2005)
Whippets (Show pedigree)	Left	10.5±0.6	9.3-11.7	Bavegems et al. (2005)
Whippets (Show pedigree)	Right	10.8±0.6	9.6-12.0	Bavegems et al. (2005)
Yorkshire Terrier	Right	9.7±0.5	8.7-10.7	Lamb et al. (2001)
Yorkshire Terrier	Right	9.9±0.6	8.7-11.1	Jepsen-Grant et al. (2013)

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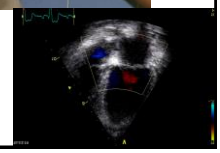
Physical Examination
Cardiopulmonary Auscultation

- **History**
- **Physical Exam**
- Radiography
- Echocardiography
- ECG
- Biomarkers/Lab tests



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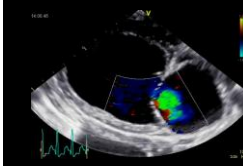
How to Diagnose MMVD

- History
- Physical Exam
- Radiography
- **Echocardiography**



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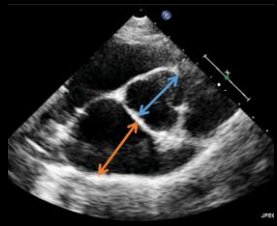

LA:Ao Ratio

(Early ventricular diastole, first frame following T wave)

Normal	1.2-1.3
Mild ↑	1.4-1.59
Moderate↑	≥1.6

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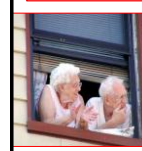
Goals of Managing Asymptomatic Dogs:



Establish Stage of MMVD

- Mild to moderate LAE (Stage B1, B2)
  - Monitor every 3-12 months
  - Radiographs (VHS)
  - Echocardiography
    - LA:Ao <1.6
    - LVDd normalized < 1.7
- Substantial LA Enlargement (Stage B2+)
  - Pimobendan (0.4-0.6mg/kg orally divided q12 hrs)
    - Monitor- breathing rate/effort,
    - Body weight; examine 2-3x/yr?

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New ACVIM Consensus Guidelines for the Diagnosis and Treatment of MMVD

Journal of Veterinary Internal Medicine

CONSENSUS STATEMENT | Open Access

ACVIM consensus guidelines for the diagnosis and treatment of myxomatous mitral valve disease in dogs

Bruce W. Keene, Clarke E. Atkins, John D. Bonagura, Philip R. Fox, Jens Häggström, Virginia Luis Fuentes, Mark A. Oyama, John E. Rush, Rebecca Stepien, Masami Uechi

First published: 11 April 2019 | https://doi.org/10.1111/jvim.15488 | Citations: 3

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Distinguish CHF vs Airway Disease

	Likelihood CHF	Likelihood Respiratory
	Orthopnea	**Coughing**
ECG	• Tachycardia; APCs, VPCs	• Resp. Sinus Arrhythmia
BNP	↑ NT-proBNP	• Normal
Echo	• MVVD • LA:Ao>1.6:1	• LA:Ao < 1.6:1 • RVE/H; PHT
Chest Rads	• VHS>10.6 • LAE; Pulmonary venous congestion • "Perihilar' infiltrate	• VHS<10.5 RAE/RVE • Collapsed Trach. • ↑Bronchointerstitial pattern

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Inspection

R-Sided CHF (Ascites, Pleural, Pericardial Effusion)

Cachexia

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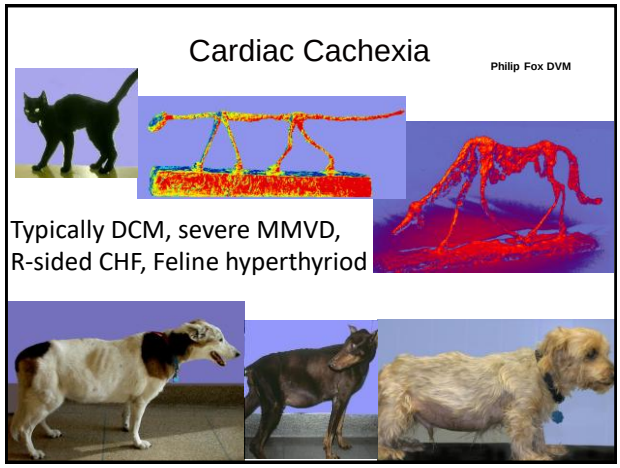
Cardiac Cachexia
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Typically DCM, severe MMVD,
R-sided CHF, Feline hyperthyriod

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Physical Examination
Patient Inspection
Jugular Vein Distention or Pulse
Courtesy Dr Lauren Wiley
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Inspection
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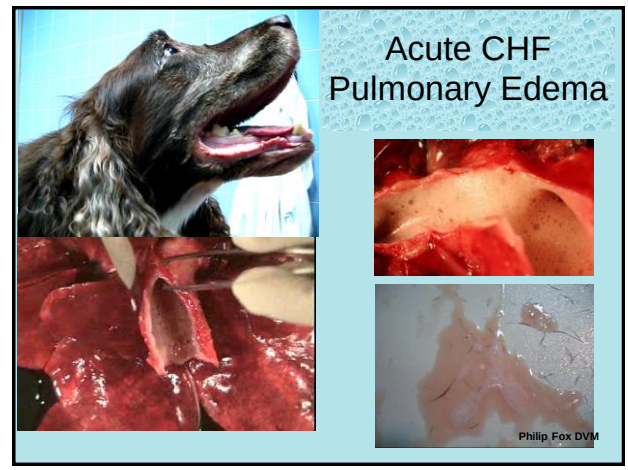
Acute CHF
Pulmonary Edema
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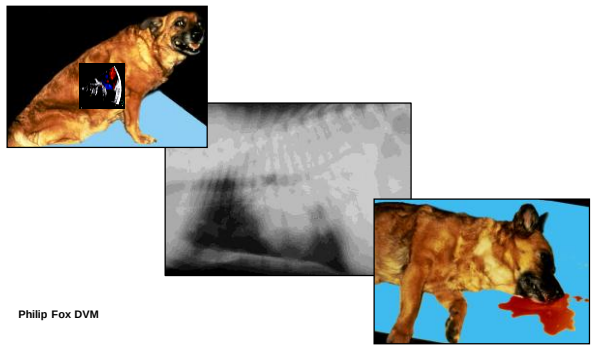
Acute Pulmonary Edema
Minimize Stress!!!



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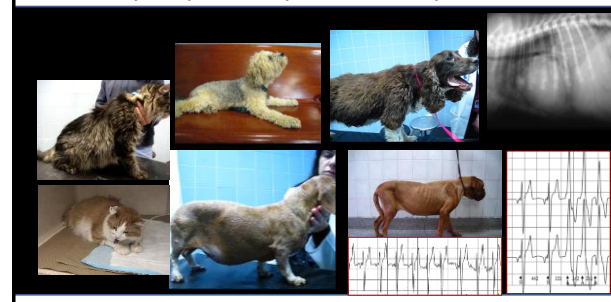
Congestive Heart Failure

Acute tachypnea; Dyspnea; Exercise Intolerance; Syncope; Tachycardia; Arrhythmias



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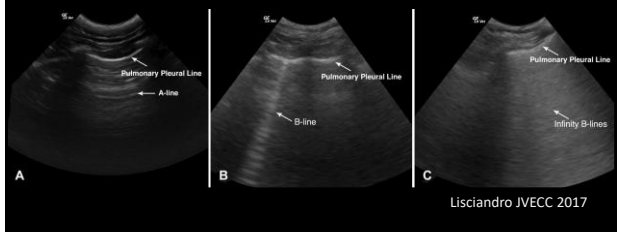
POC Echo

LA; Ao
LA:Ao
LVIDDN
Contractility
Effusions
B-Lines



Lisciandro JVECC 2017

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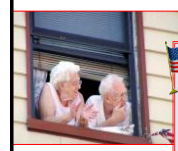
Acute CHF Management:

Stage C and D



Pulmonary Edema Goals:

- Minimize stress! Avert CP arrest
- O_2
- Rapidly remove edema
  - –**IV Diuretic;**
  - –**Vasodilators;**
  - –**Pimobendan**
- Electrolytes/BUN-Crt
- POC Echo, Chest Xrays, EGG, SBP

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Acute Pulmonary Edema
Management:

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Reduce Preload:

IV Furosemide 2-4mg/kg IV

- 1-2 mg/kg in 1 hr, then q6-8h

- Or, Initial Bolus, then 0.25-.5mg/kg/hr CRI
- Adjust dose to Clinical Endpoints
  1. Breathing (Resp Rate, Effort)
  2. Lung Sounds
  3. Crt/BUN, Electrolytes, Systolic BP
  4. Body wt

AVOID Hypotension and Renal Failure

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Acute Pulmonary Edema
Management:

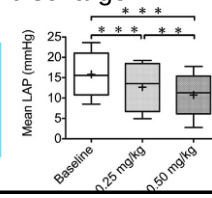
Inodilator Therapy

Pimobendan

0.5mg/kg PO q 8 hrs CHF

(Significantly reduced LA Pressure)

0.4-0.6mg/kg PO q-12 hrs discharge



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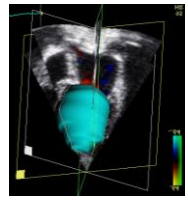
Cardiogenic Pulmonary Edema
Acute Management:

↓Resistance to LV Ejection (Afterload)

1. **Sodium Nitroprusside** 2-10ug/kg/min IV CRI

- Start at 2ug/kg/min
- ↑ by 1ug/kg/min/30 min
- Titrate to ↓RespRate, ↓ dyspneaq, lung crackles
- Maintain SBP>85mmHg



AVOID Hypotension, Renal Failure

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Cardiogenic Pulmonary Edema
Acute Management:

↓Resistance to LV Ejection (Afterload)

2**. Oral Hydralazine**

- 0.75-1.5 mg/kg PO q 8 hrs, or
- **0.5mg/kg q 1 hr + IV Lasix** Bolus to effect (avoid Hypotension, AKI)

Titrate-

SBP >85mmHg, ↓ resp. rate, ↓ lung crackles

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Cardiogenic Pulmonary Edema
When No Money? (No Problem)

↓ Preload	• Furosemide • 1mg/kg IV q 1 hr	Maintain SBP >90 mm Hg
↓ Afterload	• Hydralazine • 0.5 – 1 mg/kg PO q 1 hr	
↑ Contractility	• Pimobendan • 0.5mg/kg PO q 8 hrs	
Recheck hourly!!!!	• Systolic BP; HR/RR	

Titrate to ↓ resp. rate, ↓ lung crackles

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Arrhythmia Management Central Considerations:

Does the arrhythmia:

1. ***Trigger signs***? Syncope, weakness
2. ***Contribute to CHF***? Rapid AFib (>160bpm)
3. ***Have hemodynamic consequences*** (hypotension)
4. ***Pose risk of death*** (electrical instability)? V-Tach (rapid/sustained/ multifocal, R on T)

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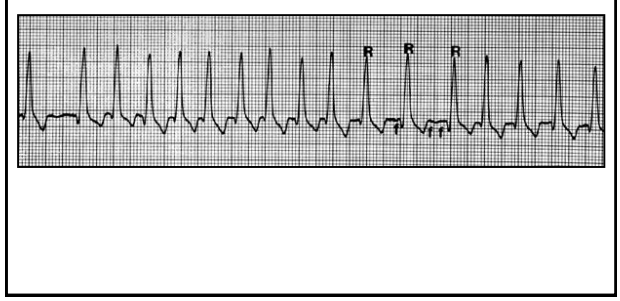
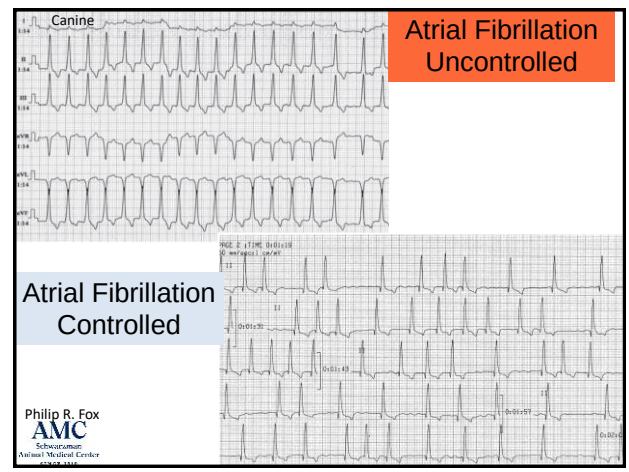


46



47

Management of Atrial Fibrillation

HR >160: Treat IMMEDIATELY
GOAL- HR 125-140bpm – Begin IV Rx

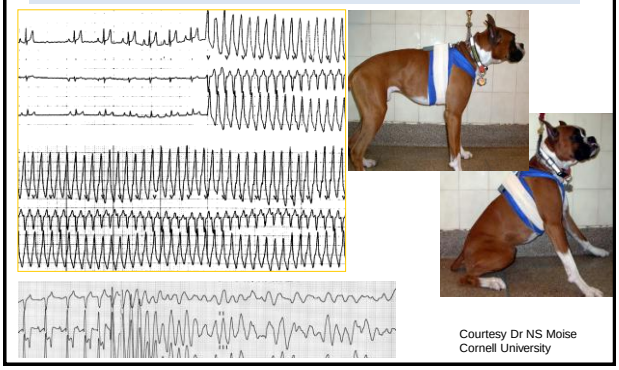
Diltiazem 0.1 mg per kg IV over 5 min x 2-3 boluses
Diltiazem CRI 2-5ug/kg/min

Digoxin bolus (0.0025mg/kg IV)- if normal Creatinine

To change from IV to oral Diltiazem:
Stop CRI x 6h
Add Ditiazem HCl 2-4mg/kg PO q8h or
Dilacor extended release, 2-4 mg/kg PO q12h

48

Ventricular Arrhythmia Management Clinical Assessment:



Courtesy Dr NS Moise
Cornell University

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Arrhythmia Management Clinical Assessment

Does arrhythmia have Hemodynamic consequenses?

- *CHF*
- *Hypotension*
- *Syncope*
- Electrical instability

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Ventricular Tachycardia May Accompany CHF, other Diseases

Unstable VT (electrical/hemodynamic) Rx **Immediately**

Goals- Convert to sinus rhythm

IV Lidocaine
Dog: 2.2 mg/kg IV (x4) 40-90 ug/kg/min CRI
Cat: 1-2 mg IV slowly (10-30 ug/kg/min CRI)
Beta-blocker Esmolol (100-500ug/kg/min IV/CRI)
IV Procainamide 5-10 mg/kg IV slowly; 25-50 ug/kg/min CRI)

Oral Sotalol 1-2mg/kg q 12 hours
Oral Mexilitine 5-8mg/kg q 8 – 12 hours with sotalol

Amiodarone IV Loading- 2-5mg/kg over 30-60 min; PO:8-10mg/kg q12-24h for 7-10days, then 4-6mg/kg q24hr

- Resolve CHF (Furosemide, Pimobendan, ACEI)
- Treat underlying conditions
- Monitor ECG, electrolytes/ renal function, SBP

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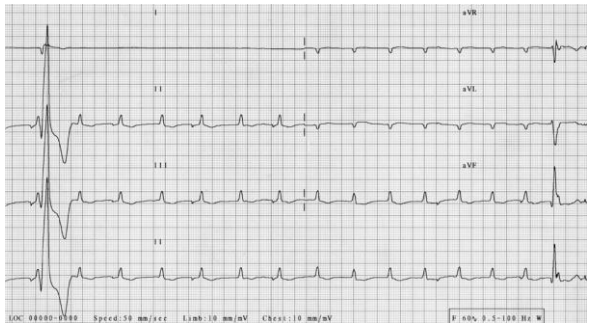
Bradycardia
Complete AV Block



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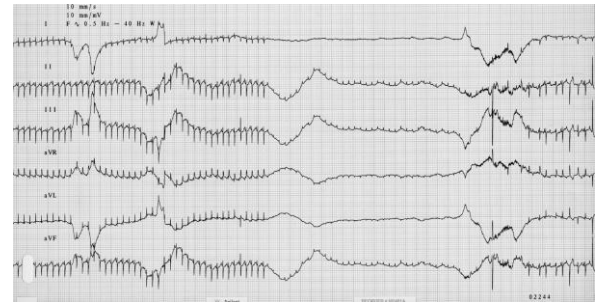
Bradycardia
High Grade AV Block



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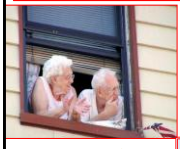
Goals of Chronic Therapy:



- Reduce morbidity/recurrence
- Improve survival
- Enhance quality of life

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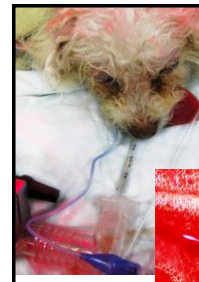
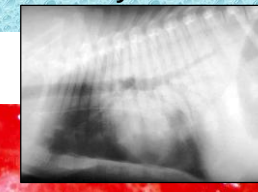
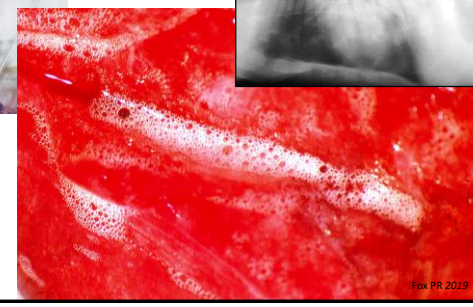
Acute Pulmonary Edema







Fox PR 2019

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Chronic CHF Therapies

First Line Drugs
- Pimobendan
- Furosemide
- +/-ACEI
- +/- Spironolactone

For Recurrent CHF
- Torsemide
- Amlodipine or Hydralazine

For Comorbidities
- Sildenefil
- Theophylline
- Hycodan

Refractory Cases
- Validate compliance
- Re-evaluate diagnosis
- Referral

57

ACE Inhibitors

Indications
- Counter RAAS activation

Administration
- Enalapril, Benazepril
- (0.5mg/kg q12-24h)

Considerations
- DCM (Dobermans) delays onset CHF
- Chronic MVD- small or no benefit in volume overload (SVEP, Vetproof)

Monitoring
- Rare side effects without diuretics
- AKI with overdiuresis
- Re✓ 3-7d post Rx, 1-3 months, q 12 months- or following increased diuretic dose

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Spironolactone

Indications
- Adosterone antagonist (RAAS)
- Promotes fluid retention, vascular & myocardial remodeling
- Elevate despite ACEI

Administration
- Given with ACEI and diuretics
- 2 mg/kg q12h PO

Monitoring
- Rare side effects

Considerations
- Strong efficacy data in people
- Uncertain benefit, dogs

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Chronic Management

1. Client Monitoring
- Teach resp. rate (normal < 30)
- Anorexia, weakness, cough, syncope

2. DVM Monitoring
- Radiographs
- Creat./lytes/SBP/ECG
- Echo (if symptoms)

3. Expect recurrences
- Risk/Life expectancy
- Reset concept of maximal dosages

Lasix, Spironolactone, ACEI, Amlodipine

4. Quality of Life
- Coughing- manage
- Cardiac cachexia- nutritional consult

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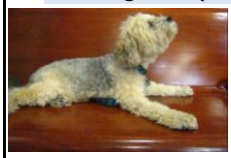
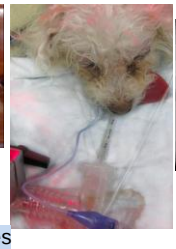
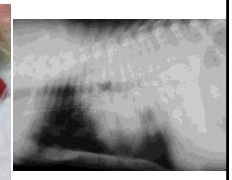
Chronic Valvular Heart Disease Stage D (Refractory to standard Rx)

- Maximize drug doses
- Change furosemide to torsemide- 0.1-0.4mg/kg q 12-24 hr
- Dietary Management
- Off-label drug doses- Pimobendan q8 hr
- Amlodipine; Digoxin

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Chronic Valvular Heart Disease Stage D (**Refractory** to standard Rx)

Reassess Diagnosis
- Comorbidities?
- Pulmonary hypertension?
- Tachyarrhythmias?
- Mocardial failure?

PHT and R CHF
- Sildenefil 3-8mg/kg q8-12hr

Monitor Creatinine, electrolytes, SBP, Body wt, QOL

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Chronic Valvular Heart Disease Stage D (**Refractory** to standard Rx)

Diuretic Resistance
(ie Furosemide>8mg/kg/d)

Torsemide
- (0.1mg/kg q12-24h;
- tot. daily furosemide dose x 0.1 q24h)

Hydrochlorthiazide
- 6.25-12.5mg q 24-48 hr PO

Hydralazine 2mg/kg q12hr

Amlodipine
0.1mg/kg q12h PO, titrate q1wk to 0.4mg/kg q 12 hr

Monitor Creatinine, electrolytes, SBP, Body wt, QOL

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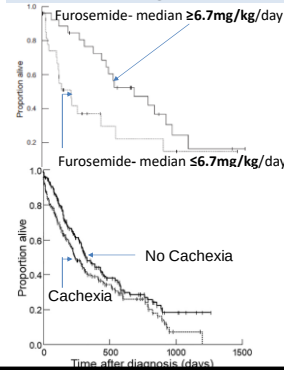
Survival: Dogs with Advanced CHF



Beaumier. Clinical findings and survival time dogs with advanced CHF. JVIM;2018
- MMVD n=50
- Recurrent CHF
- Median survival- 9.4 mo. -281 days (3-885 days)

Ineson. Survival time with cardiac cachexia in dogs with CHF. JVIM;2019
- CHF n=269 (MMVD 81% /DCM 19%)
- 42-48% had cardiac cachexia
- Median survival (all dogs) 9.4 mo. - 291 days (0-1264 days)

65

Home Care Focus

- Compliance
- Home monitoring
  - Breathing rate
  - Body weight
  - Heart rate/rhythm?
- Diet
- Activity
- Quality of life
  - Appetite / treats
  - Urinary continence
  - Medication interval
  - Activity
  - Costs
  - Recheck frequency
  - Advice

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Primary Care Focus

- Accuracy of diagnosis
- Comorbidities
- Prognosis 3-18 months post 1st CHF
- Evidence-based practice guidelines
  - At every stage of disease (interface w/ specialist care)
- Clinical monitoring
  - Renal function / electrolytes
  - Body weight (expect cachexia)
  - ECG / radiographs
  - Arterial blood pressure
- Follow-up phone care / reminders
- Emergency service / advice

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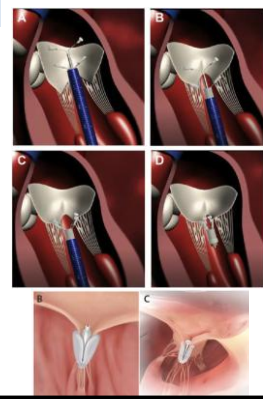
TEER

- Transcatheter Edge-to-Edge Repair (TEER)
- Minimally invasive procedure that treats severe mitral valve regurgitation
- Body wt. 4-15kg
- Absence of signif. Noncardiac disease
- Fullfill echo/Doppler parameters



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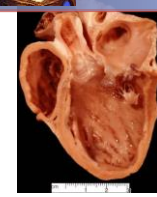
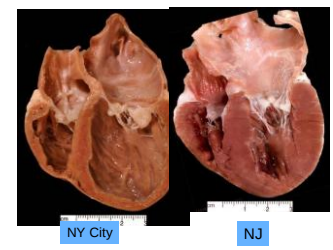
Cavalier King Charles Spaniel



Sweden



NY City

NJ

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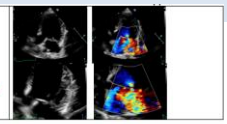
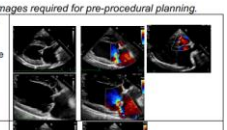
Essential Images for TEER Candidacy

Left parasternal apical five-chamber view
- 2D
- Color Doppler on MV (include entire LA)
- Zoomed image of valve
  - 2D
  - Color Doppler on zoomed image
- Essential

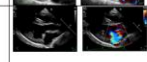


- *Additional echocardiographic images required for pre-procedural planning.*

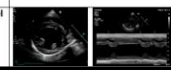
Right parasternal long-axis 4-chamber view
- 2D (optimized for LA and LV)
- Color Doppler on MV (include entire LA) and TV
- Zoomed image of MV
  - 2D
  - Color Doppler on zoomed image



Right parasternal long-axis inflow-outflow view
- 2D
- Color Doppler on MV



Right parasternal short-axis (LV at level of papillary muscles)
- 2D
- LV M-mode



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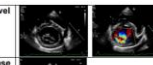
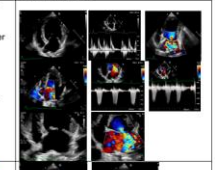
Right parasternal short-axis (LV at level of mitral valve)
- 2D
- Color Doppler



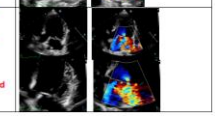
Right parasternal short-axis (heart base – aorta and LA)
- 2D

Subcostal view
Aortic flow velocity - PW Doppler at valve

Left parasternal apical four-chamber view
- 2D
- MV inflow velocities – PW Doppler
- Color Doppler on MV and TV
  - MR CW Doppler
  - TR CW Doppler
- Zoomed image of MV
  - 2D
  - Color Doppler on zoomed image

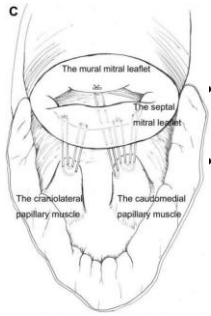


Left parasternal apical five-chamber view
- 2D
- Color Doppler on MV (include entire LA)
- Zoomed image of valve
  - 2D
  - Color Doppler on zoomed image
- Essential



71

Uechi et al. **Mitral valve repair under cardiopulmonary bypass in small-breed dogs: 48 cases (2006-2009).**
J Am Vet Med Assoc. 2012 May 15;240(10):1194-201.



- Mitral valve repair under cardiopulmonary bypass
- Circumferential annuloplasty and chordal replacement

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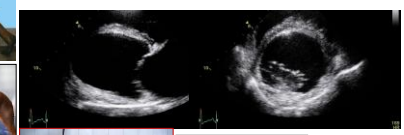
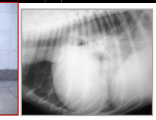
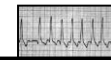
What About Dilated Cardiomyopathy?







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Congestive Heart Failure

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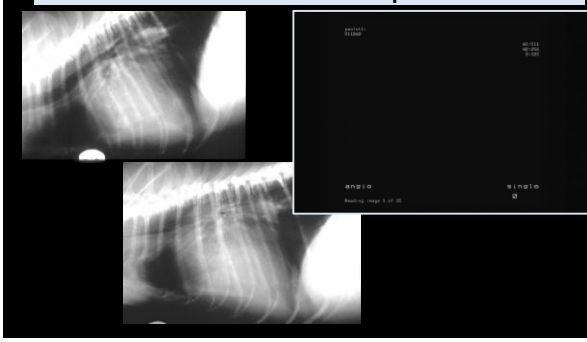
Comorbidity
Dynamic Large Airway Obstruction
Tracheal “Collapse”



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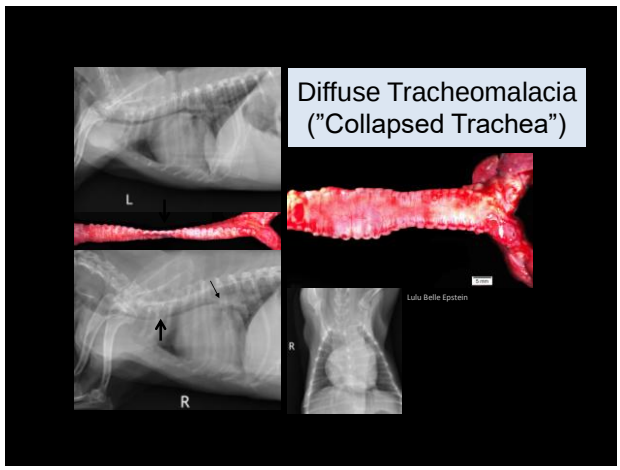

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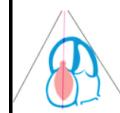
Pulmonary Hypertension in Left Heart Disease (Comorbidity)



Use TR signal to measure PA systolic gradient

1. Align Beam to optimal TR
2. Record CW Doppler
3. Measure TR max
4. PA systolic gradient =4x(TR velocity)^2

Mild TR

Severe Tricuspid Regurgitation

<4m/sec (64mm Hg) “Upper limit for PHT due to severe MR

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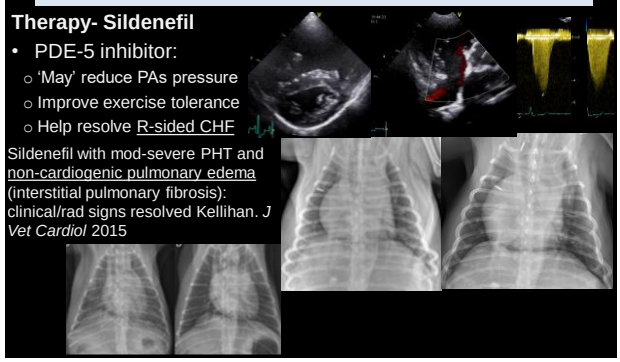
Pulmonary Hypertension

Therapy- Sildenefil

- PDE-5 inhibitor:
  - ‘May’ reduce PAs pressure
  - Improve exercise tolerance
  - Help resolve R-sided CHF

Sildenefil with mod-severe PHT and non-cardiogenic pulmonary edema (interstitial pulmonary fibrosis): clinical/rad signs resolved Kellihan. *J Vet Cardiol* 2015



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Pulmonary Hypertension Cardiac vs Respiratory Disease

TR Velocity (m/s)- estimated PA systolic	Asympt. No Heart Disease	Asympt. Heart Disease	Resp. Distress Lung or Airway	Resp. Distress CHF
2.8 - 3.5 Mild	0	12(15%)	15 (14%)	20 (27%)
>3.5-4.3 Mod	0	1 (1%)	18 (17%)	7 (9%)
>4.3 Severe	0	1 (1%)	9 (9%)	9 (12%)

Sildenefil 2-8mg/kg PO q 8-12 hours

Fox PR JVIM 2014

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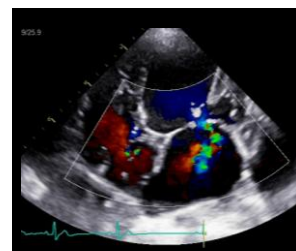
Heart Disease / Congestive Heart Failure Which Patients might Die? …and When?

80

MMVD- What are the Comorbidities?



R-Sided CHF (Ascites, Pleural, Pericardial Effusion)

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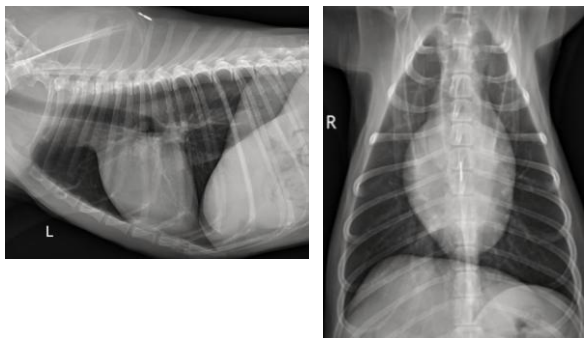
Diagnosis?



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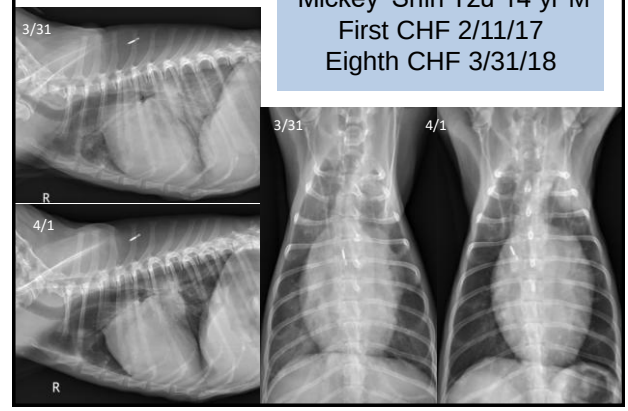
‘Mickey’ Shih Tzu 14 yr M
First CHF 2/11/17
Eighth CHF 3/31/18



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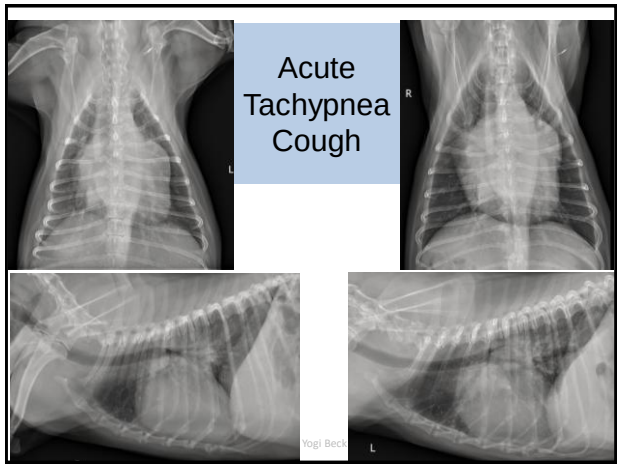
Acute
Tachypnea
Cough



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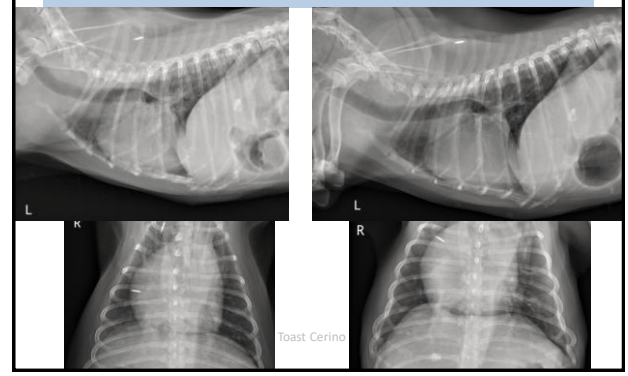
Acute Dyspnea



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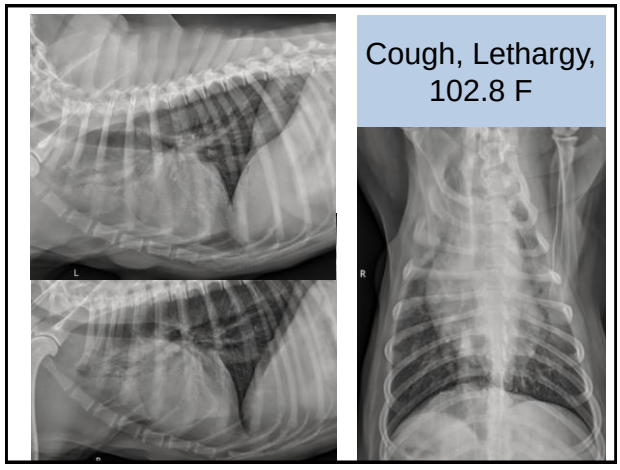
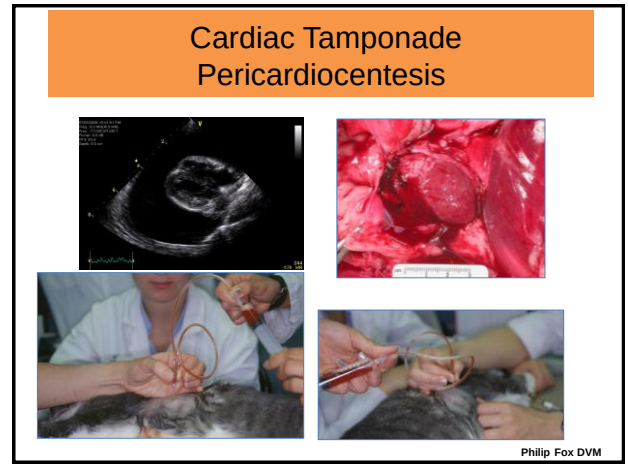

Cough, Lethargy,
102.8 F

86


Cardiac Tamponade
Pericardiocentesis
Philip Fox DVM

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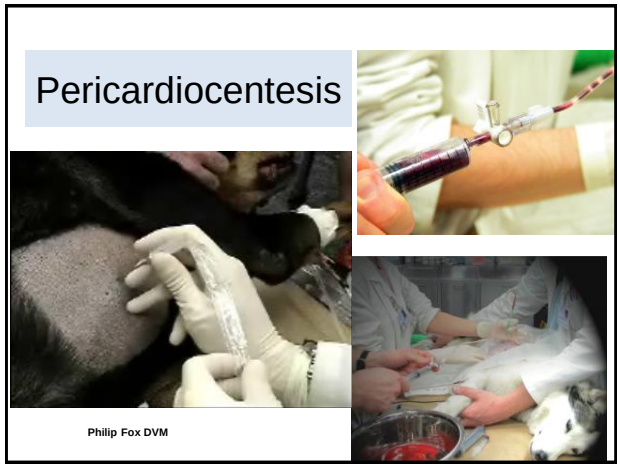
Pericardiocentesis
Philip Fox DVM

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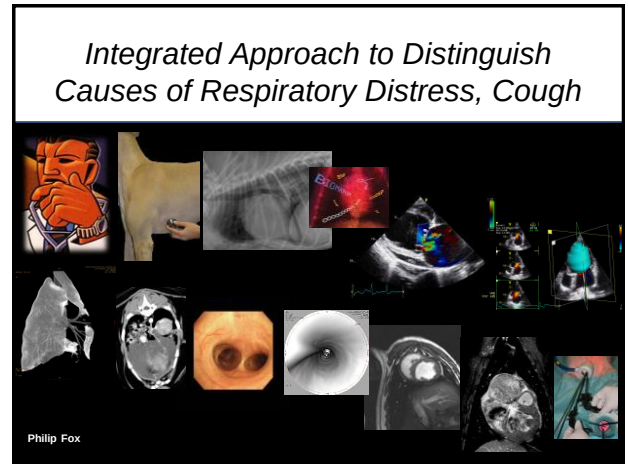
Integrated Approach to Distinguish
Causes of Respiratory Distress, Cough
Philip Fox

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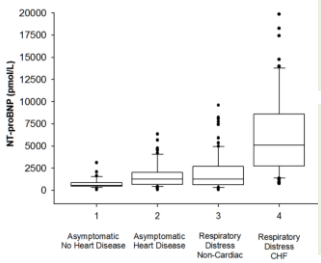
JVIM 2014

Relationship of Plasma N-terminal Pro-brain Natriuretic Peptide Concentrations to Heart Failure Classification and Cause of Respiratory Distress in Dogs Using a 2nd Generation ELISA Assay

P.R. Fox, M.A. Oyama, M.J. Hezzell, J.E. Rush, T.P. Nguyenba, T.C. DeFrancesco, L.B. Lehmkuhl, H.B. Kellihan, B. Bulmer, S.G. Gordon, S.M. Cunningham, J. MacGregor, R.L. Stepien, B. Leibom, D. Adin, and K. Lamb



BNP **>2,447** pmol/L discriminated CHF from noncardiac respiratory distress

- **81**% sensitivity, **73**% specificity

Clinical parameters that best linked BNP to heart disease severity:

- LA:Ao ratio
- LV end-systolic diameter
- Heart Rate
- ACVIM Classification Scheme

Philip Fox DVM

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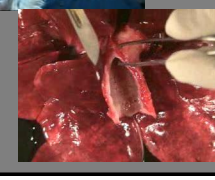
Progression of Heart Disease to CHF



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