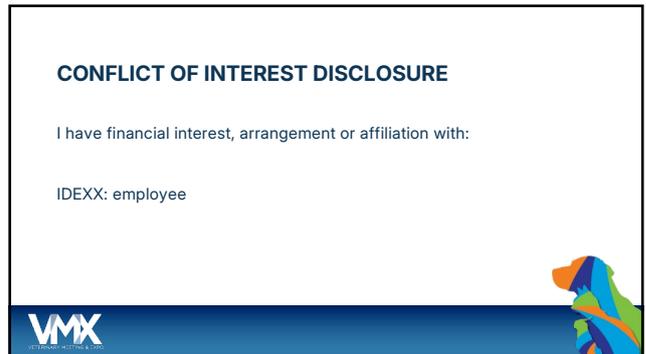
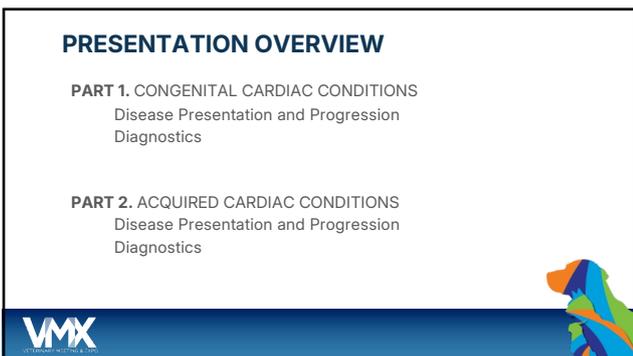


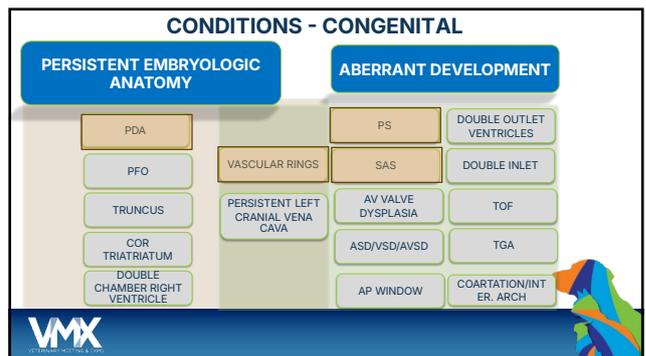
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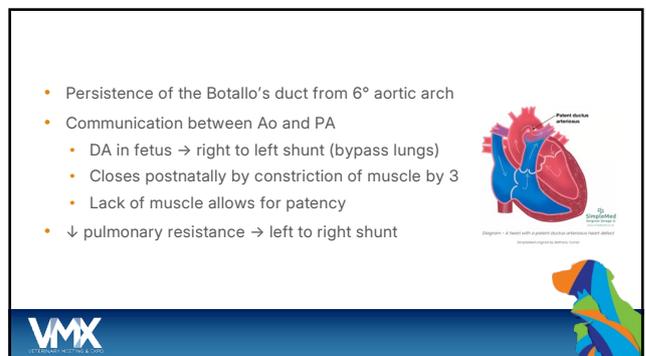
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5



6



7

Continuous shunting from left to right as in "normal" conditions the pressure in Ao > pressure PA throughout cycle

- Loads PA, lungs, left side
- Causes left sided overload and CHF

**VMX**  
<https://www.clinicaladvisor.com/features/patent-ductus-arteriosus-in-adult-and-pediatric-populations/>

8

	LEFT-TO-RIGHT		RIGHT-TO-LEFT
	Restrictive	Nonrestrictive with low pulmonary resistance	Nonrestrictive with suprasystemic pulmonary vascular resistance
<b>SIGNS</b>	Asymptomatic	CHF	Differential Cyanosis
<b>ARTERIAL PULSE</b>	Normal, wide, bounding	Wide, bounding	Normal (+++)
<b>AUSCULTATION</b>	Continuous murmur at heart base Thrill throughout sys-dia	Murmur and thrill may be just in sys or absent	Murmur absent

**VMX**

9

**VMX**

10

- **Asymptomatic**
  - Identified due to presence of murmur
- **CHF**
  - Pulmonary edema, respiratory distress
- **Reversed PDA**
  - Dogs → happens over short time
    - May miss the "reversal" phase
  - Cats → can occur over longer period
    - Witness the switch
    - Continuous → Systolic → absent
  - Evidence of cyanosis and polycythemia
    - Increased PCV (70-80%) due to hypoxemia

**VMX**

11

**The "reversed" shunt**

Eisenmenger syndrome is a complication of untreated congenital heart defects (such as large unrepaired VSD, ASD, or PDA) where the direction of blood flow in the heart reverses due to severe pulmonary hypertension.

↑pulmonary flow → pulmonary vascular damage  
 Protects lungs → Develop pulmonary hypertension

PH allows reversal of shunt → R to L PDA  
 PRESSURE load on RIGHT side

**VMX**

12

Differential cyanosis (cranial = pink, caudal = blue)

**VMX**

13

### DIFFERENTIAL DIAGNOSES

- Conditions producing To-and-fro murmurs instead of continuous (combo systolic and diastolic)
- Aortopulmonary fistula
- Aortopulmonary windows

1st 2nd 3rd Atrial

Normal

Aortic stenosis

Patent ductus arteriosus

Aortic regurgitation

VMX

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### ECG

- Non-specific
- Left sided chamber enlargement with left-to-right shunt
  - Wide P waves → LAE, Tall R waves → LVE
- Right ventricular hypertrophy and peak P wave with right-to-left shunt

### RADIOGRAPHS

	Left-to-Right	Right-to-Left
	<i>Moderately Restrictive</i>	<i>Nonrestrictive with low pulm. resistance</i>
	<i>Nonrestrictive with suprasystemic pulm. resistance</i>	
Left heart enlargement	Enlargement of all four chambers	Reduced pulmonary vascularity
Increased pulmonary vascularity	CHF	Dilation pulmonary trunk
Enlarged pulmonary trunk		Hypertrophy RV
Prominent ascending Ao		Normal or near normal left heart

VMX

16

Courtesy Dr B. Scansen

VMX

17

VMX

18

### VASCULAR RINGS

VMX

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RIGHT BRACHIOCEPHALIC

LEFT COMMON CAROTID

LEFT SUBCLAVIAN

LS

LA

CC

EC

MPA

AA

LA

RS

CC

EC

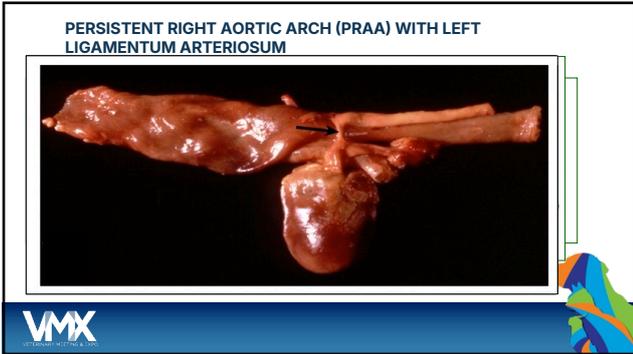
LS

MPA

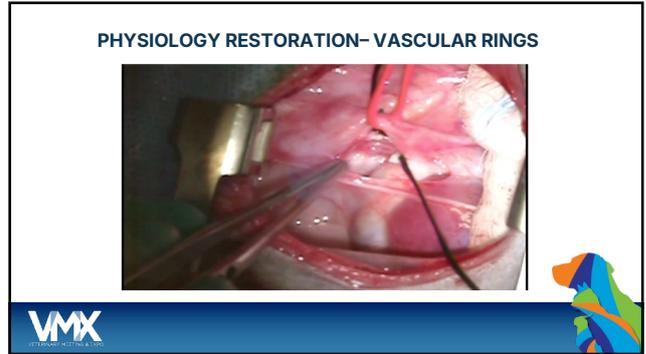
Right L Left

VMX

20



21



22

**PULMONIC STENOSIS**

**BREEDS**

English bulldog, French bulldog, Mastiff, American pit bull terrier, Miniature schnauzer, West Highland white terrier

VMX  
VETERINARY MEDICAL X-RAY

27

- Ejection quality, systolic left heart base murmur
- Normal pulse quality and lung sounds
- Persistent foramen ovale is often present
- Dog may be asymptomatic or exhibit signs such as: exercise intolerance, dyspnea, cyanosis

VMX  
VETERINARY MEDICAL X-RAY

28

**VALVULAR STENOSIS**

- With or without annulus stenosis
- With or without aberrant coronary

**SUBVALVULAR STENOSIS**

- Fibrotic or muscular stenosis
- Aberrant coronary artery

**SUPRAVALVULAR STENOSIS**

- Rare

VMX  
VETERINARY MEDICAL X-RAY

29

VMX  
VETERINARY MEDICAL X-RAY

30

**ECG**

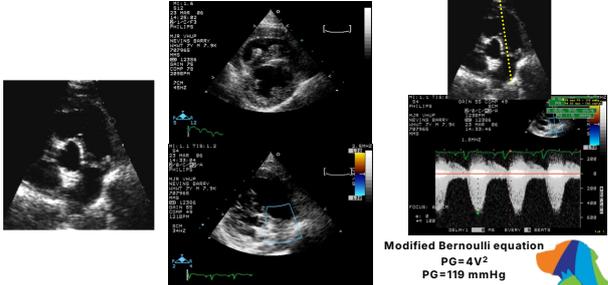
- RVH

**RADIOGRAPHS**

- Right ventricular enlargement; cardiac apex may be lifted off the sternum
- Post-stenotic dilation
- Lung fields normal or hypoperfused



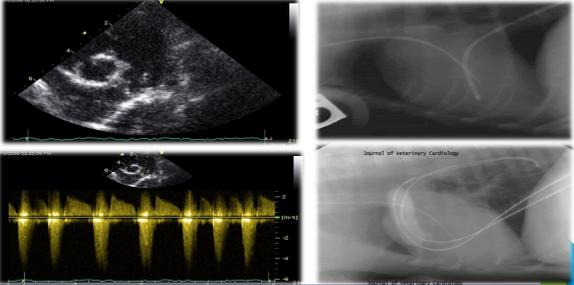
31



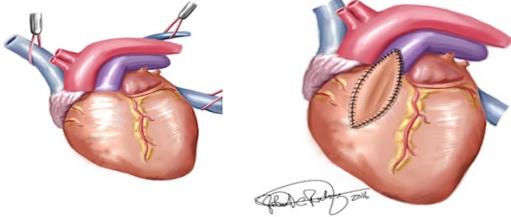
**Modified Bernoulli equation**  
 $PG = 4V^2$   
 PG = 119 mmHg



32




33




34

**SUBAORTIC STENOSIS**

**BREEDS**

Newfoundland, Golden Retriever, Dogue de Bordeaux, Rottweiler, Bouvier de Flandres, Bullmastiff




35

**Fixed Subaortic Stenosis:** fibrotic band with possible concurrent malformation of the mitral valve

**Subvalvular stenosis** is most common in dog, but supravalvular may be more common in cats

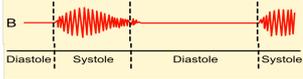
Sometimes tubular fixed stenosis

Usually isolated but may occur with mitral valve dysplasia




36

- Common in dog, rare in other species
- Often asymptomatic, but may have history of fatigue, syncope or sudden death
- Ejection quality systolic murmur at the left heart base
- Murmur or bruit may extend up the carotid arteries
- Poor pulse quality with moderate to severe disease
- +/- arrhythmias and pulse deficits



Diastole Systole Diastole Systole




37

**ECG**

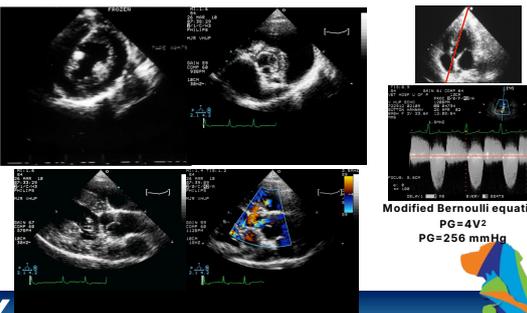
- Normal or LVH, ST segment deviation and arrhythmias with severe disease

**RADIOGRAPHS**

- Often unremarkable, but left ventricular enlargement is possible
- Aortic root dilation



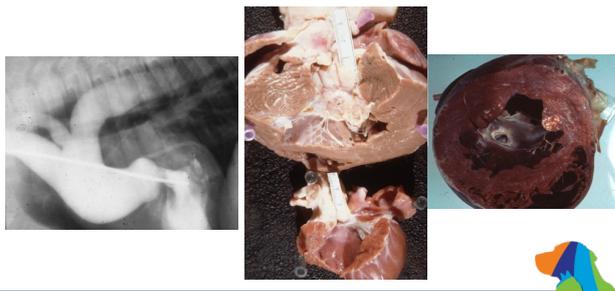

38



Modified Bernoulli equation  
 $PG = 4V^2$   
 $PG = 256 \text{ mmHg}$




39





40

**CONDITIONS - Acquired**

DEGENERATIVE VALVE DISEASE

ALTERATION OF ANATOMY

DCM

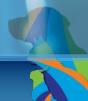
HCM




41



DCM

42



43

### DEFINITION



A heterogeneous group of diseases whose commonalities are **substantial morphologic and/or functional abnormalities of the myocardium**.

Though it could involve any heart chamber, it usually refers to the ventricular myocardium




44

Fairly common problem in small animal medicine

- 0.5% of the dogs evaluated at U.S. referral-hospitals were diagnosed with DCM from 1986 to 1991 (Sisson et al., 2000)
- 0.4% of the dogs evaluated in a US hospital (90,004) from 1995 and 2010; subset of dogs with an inherited disease (27,254 cases) presented an incidence rate of 1.3% (Bellumori et al. 2013)
- 1.1% of the dog population seen at veterinary hospitals (Fioretti and Delli, 1988)

Substantial impact on morbidity & mortality

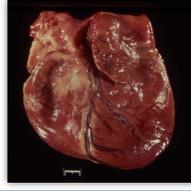
Though only rarely curable (except for some secondary cardiomyopathies), effective "palliative" therapy is possible in many cases

GENETIC COUNSELING for familial forms




45

- Dilated chambers
  - Left atrium/ventricle
  - Right side also affected
- Histopath changes
  - Fibrous tissue
  - Fatty infiltration






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TYPES CARDIOMYOPATHIES	Classification
ISCHEMIC CARDIOMYOPATHY (hypothyroidism ?)	Etiologic
TOXIC CARDIOMYOPATHY [alcoholic, drug-induced ex. doxorubicin]	Etiologic
NUTRITIONAL/DEFICIENCY CARDIOMYOPATHY <ul style="list-style-type: none"> <li>• BEG (Boutique, exotic meats &amp; grain free) diets</li> <li>• L-carnitine</li> <li>• Taurine deficiency</li> </ul>	Etiologic
MYOCARDITIS (autoimmune & infectious)	Etiologic
TACHYCARDIA-INDUCED CARDIOMYOPATHY	Etiologic
INFILTRATIVE CARDIOMYOPATHY <ul style="list-style-type: none"> <li>• amyloid</li> <li>• neoplastic</li> </ul>	Morphologic
HYPERTROPHIC CARDIOMYOPATHY	Morphologic
DILATED CARDIOMYOPATHY	Functional
Subset: familial Cardiomyopathy (genetic) [Ex. Dobermann, "Boxer" cardiomyopathy, Portuguese Water dog]	Genetic

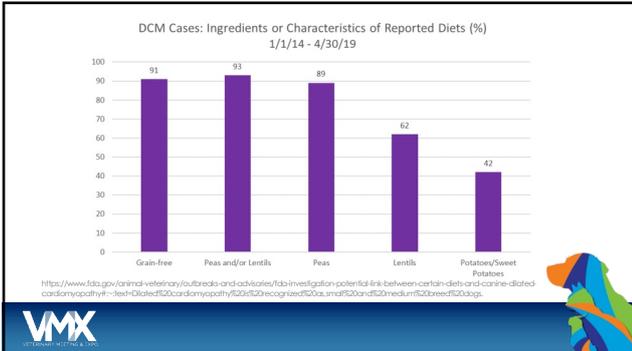



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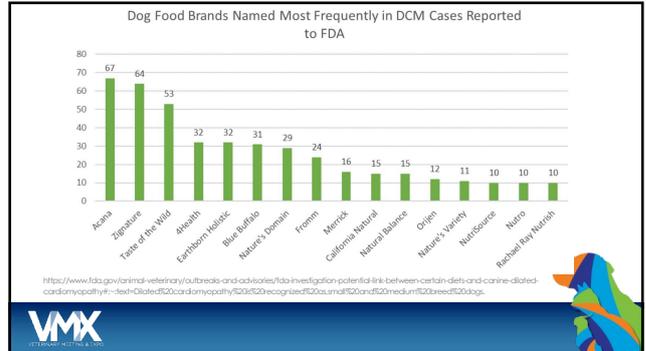
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49



50



52

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**Parvovirus Infection Is Associated With Myocarditis and Myocardial Fibrosis in Young Dogs**

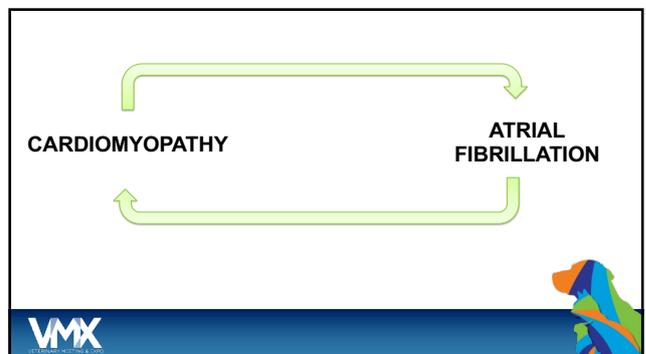
Jordan Ford<sup>1</sup>, Laura McEndaffer<sup>1</sup>, Randall Renshaw<sup>2</sup>, Alex Molesan<sup>1</sup>, and Kathleen Kelly<sup>1</sup>

INCLUSION BODIES

57

TYPES CARDIOMYOPATHIES	Classification
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59

TYPES CARDIOMYOPATHIES	Classification
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TOXIC CARDIOMYOPATHY [alcoholic, drug-induced ex. doxorubicin]	Etiologic
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60



- Large & giant breed dogs preferentially affected
- 58% of Doberman Pinschers affected by DCM [Wess et al. 2010 and Dutton et al. 2018] and up to ~25% of Boxers affected by ARVC [Stern et al. 2010].

**BREEDS**

- Suggests a familial / genetic basis
- Great Dane, Doberman Pinscher, Portuguese Water Dog, Irish Wolfhound, Newfoundland, Boxer, Welsh Springer Spaniels, and Cocker Spaniel

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Name	Breed affected	Disease	Gene involved	Mutation type	Biological result	Mode of inheritance	Penetrance
DCM1	Doberman Pinscher	Dilated cardiomyopathy	Pyruvate dehydrogenase kinase 4 (PDK 4)	16 Base pair deletion	Altered cardiomyocyte metabolism with preferential glucose oxidation	Autosomal dominant	68%
DCM2	Doberman Pinscher	Dilated cardiomyopathy	Titin	Single base pair (missense) change from C to T	Incompletely understood; hypothesized changes to secondary structure resulting in titin unfolding and degeneration	Autosomal dominant	47%
Striatin	Boxer	Arrhythmogenic right ventricular cardiomyopathy	Striatin		Altered electrical conduction and structural integrity between myocytes	Autosomal dominant	72%



62

Name	Breed affected	Disease	Gene involved	Mutation type	Biological result	Mode of inheritance	Penetrance
Striatin	Boxer	Arrhythmogenic right ventricular cardiomyopathy	Striatin	8 Base pair deletion	Altered electrical conduction and structural integrity between myocytes	Autosomal dominant	72%



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### "BOXER CARDIOMYOPATHY"

**ARVC Arrhythmogenic right ventricular cardiomyopathy (ARVC)**

Present with ventricular arrhythmias

- In U.S., the echo is usually normal (>90 %)
- No MR (no murmur)
- ECG (especially Holter exam) shows VPCs - 'left bundle branch block morphology' because originate in the RV
- Sometimes have dilated LV with systolic impairment
- In rare cases have marked RV dilation and dysfunction



65

### CLINICAL MANIFESTATIONS

- Ventricular arrhythmias can be the first (but often missed) manifestation (OCCULT)
- Heart enlargement and poor systolic function are the final morphologic and clinical forms
- Syncope and/or CHF signs are the usual trigger to seek veterinary advice



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### OCCULT PHASE

ASYMPTOMATIC (DEFINITION)

Echocardiographic changes

- LV dilation
- Systolic dysfunction
- Mitral regurgitation

May have arrhythmias

- Usually ventricular
- Identify by Holter





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### From the OWNER's Perspective

- ✓ Fast breathing when resting or sleeping (> 30-35 breaths per minute)
- ✓ Increased effort associated with breathing
- ✓ Restless sleeping, moving around a lot and changing positions
- ✓ Coughing or gagging
- ✓ Weakness
- ✓ Reduced ability to exercise
- ✓ Collapse or fainting
- ✓ Decreased appetite
- Weight loss
- ✓ Distended abdomen
- ✓ Depressed attitude or quiet and not interactive
- ✓ Sudden death




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### From the CLINICIAN's Perspective

Usually starts with an "Index of Suspicion"

- **Detecting environmental causes / triggers**
  - Nutrition (strange diets in cats – taurine deficient)
  - "Toxins" – doxorubicin
- **Family history and signalment**
  - Dobermans, Boxers, Main Coon cats, Ragdoll cats, etc
- **Clinical history & Physical Exam**
  - Syncope
  - CHF (left or right or both)
  - Murmur (left apical systolic) or Gallop sounds (S3)
  - Arrhythmias: VPCs or Atrial fibrillation




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### Differentials to Consider

- Acutely Depressed systolic function caused by:
  - Drugs (anesthesia, high dose beta blockers, etc)
  - Myocardial depressant factor
    - Liberated by severe abdominal visceral disease
- Chronically depressed systolic function caused by:
  - Atrial fibrillation




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### DIAGNOSTIC TESTS

- Genetic testing
- Echo / Rads
- ECG (including Holter recordings)
- Bioassays
  - Plasma taurine etc





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### NT-PROBNP ASSAY

SCREENING TOOL

Usefulness of cardiac biomarker screening to detect dilated cardiomyopathy in Dobermanns

J. Dixon-McEwan<sup>1</sup>, K. E. Gawn<sup>2</sup>, J. Lopez Alvarez<sup>3</sup>, P. Oliveira<sup>4</sup>, P. E. Monticelli<sup>5</sup> and R. Willis<sup>6</sup>

FOLLOW UP

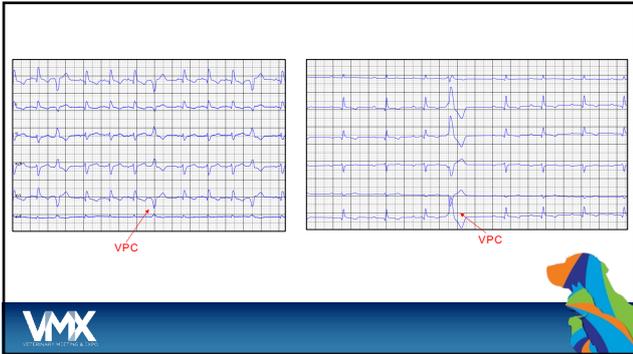
Prospective Evaluation of NT-proBNP Assay to Detect Occult Dilated Cardiomyopathy and Predict Survival in Doberman Pinschers

G.E. Singletary, N.A. Morris, M. Lynne O'Sullivan, S.G. Gordon, and M.A. Oyama

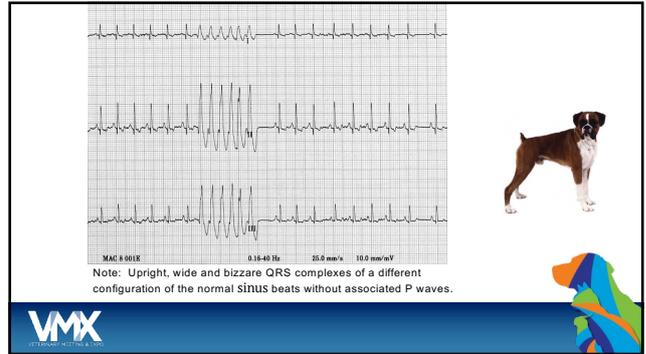
PREDICTION OF SURVIVAL



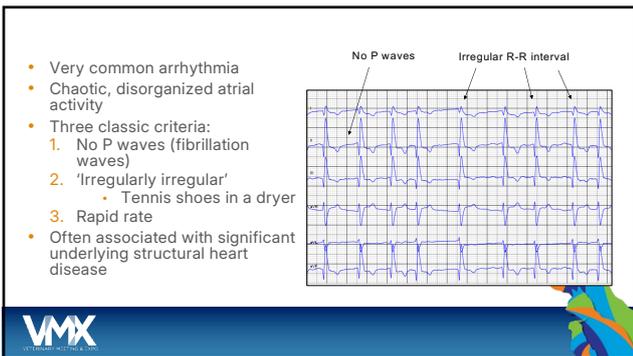

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74



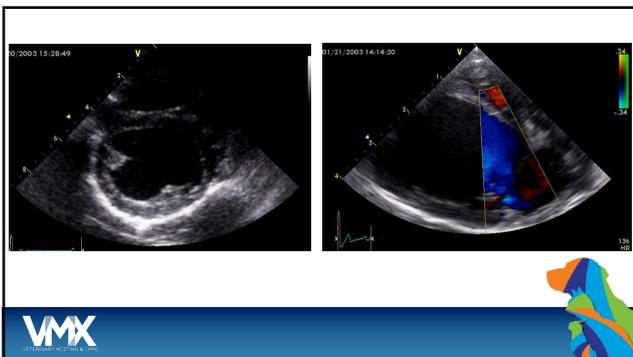
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80



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### DEFINITION

A heterogeneous group of diseases whose commonalities are substantial morphologic and/or functional abnormalities of the myocardium.

- Electrical right ventricular arrhythmia
- Mechanical Systolic dysfunction → DCM or Diastolic dysfunction → HCM/RCM
- Those that don't quite fit Unclassified cardiomyopathy (UCM)

INCIDENCE:

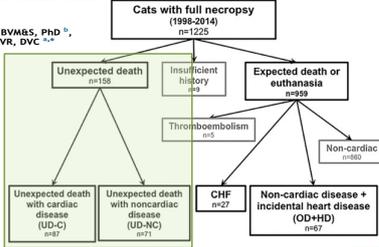
- Hypertrophic cardiomyopathy is the most common form identified in humans [Maron et al. 1995] and felines [Payne et al. 2015], with prevalence 10-15% in felines [Payne et al. 2015,6].



85

### Cardiac pathology findings in 252 cats presented for necropsy; a comparison of cats with unexpected death versus other deaths\*

L.J. Wilkie, BSc, BVetMed<sup>a</sup>, K. Smith, BVMS, PhD<sup>b</sup>, V. Luis Fuentes, MA, VetMB, PhD, CertVR, DVC<sup>a,c</sup>




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- Usually a familial / genetic condition that we see primarily in cats, & rarely in dogs or other species
  - Most common acquired adult cat heart disease
- Variable, but potentially serious effects on morbidity and mortality




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### Forms of HCM

**GENERALIZED HCM**

- Free wall, septum, papillary muscles

**OBSTRUCTIVE HCM**

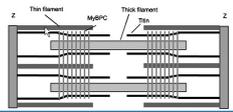
- Systolic anterior motion (SAM) of mitral valve
  - MR with LVOT turbulence
- HOCM = HCM + SAM



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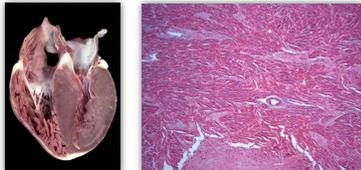
### HCM – Known Etiology

- Mutation in myosin binding protein C
  - Different mutation for M. Coon, and Ragdoll cats (two known mutations, one suspected, others likely >400 known for humans)
  - Male predilection (in some studies 3:1)




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- Thickened muscle, particularly LV septum
- Fibrosis, intramural coronary artery disease
- Marked myofiber disarray




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**Signalment; breeds at risk** (Maine coon, Ragdolls, Sphynx), males predisposed, increased age

**Owner's perspective:** often no signs, exercise intolerance, increased respiratory rate

**Physical Exam**

- Gallop "rhythm" or sound
- Adult onset murmur (particularly if III-IV/VI or greater)
- Signs of respiratory distress (tachypnea, dyspnea)

**Thromboembolism** Lameness / paralysis, pain, poor or no pulse

**Echocardiography** – usually the key to diagnosis



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**Differential diagnosis**

- Other causes for hypertrophy
  - Systemic hypertension
  - Hyperthyroidism
  - Acromegaly
- Often cannot definitively distinguish HCM from these other possibilities (LVH looks similar for all), but gallop sounds, and clinical signs of CHF are very rare with these other causes of LVH and strongly suggest HCM
- Severe** LVH is likely to be HCM
- BNP assay?
- Genetic testing ?




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**RESTRICTIVE (RCM)/ UNCLASSIFIED CARDIOMYOPATHY (UCM)**

- Muscle wall becomes fibrotic or stiff
  - Not hypertrophic
- Diastolic dysfunction
  - Biatrial enlargement
- Also has systolic dysfunction
  - Not as bad as DCM
- Commonly manifests as heart failure



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**DILATED CARDIOMYOPATHY (DCM)**

- Diet cardiomyopathy:
  - Taurine deficiency in diet (historical and uncommon)
  - Diet (unknown cause): low and high pea/lentil diets (Karp et al 2021)
- Eccentric hypertrophy: Left ventricular dilation & Systolic dysfunction
- Very poor prognosis
  - Unless it is reversible (taurine deficiency)



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Hiding from owners for a couple days

Then, dyspnea and/or tachypnea

Can present with pleural effusion or pulmonary edema (dyspnea vs. tachypnea)

May or may not have a previous (or current) murmur




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**HCM – Clinical Manifestations**

- Normal systolic function
- Variable degrees of diastolic failure (none to severe)
- Asymptomatic
  - Not uncommon, especially if heart rate is consistently below 200 bpm in exam setting
- Left sided CHF
- Sudden death (~5-15%)
- Aortic thromboembolism (5-15%)



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- Available tools
  - Blood work
  - proBNP
  - Electrocardiography
  - Blood pressure monitoring
  - Radiography
  - Echocardiography
- Variable availability
- Non-uniform quality



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### Cardiac vs non-cardiac respiratory distress

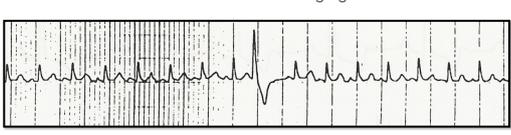
NTproANP	85 dyspneic cats (44 cardiac)	Both NTproANP <sup>®</sup> and NTproBNP <sup>†</sup> were able to discriminate between cardiac and non-cardiac patients, but NTproBNP better performance (cut-off 220 pmol/L, AUC 0.96)	Connolly <sup>®</sup>
NTproBNP	162 dyspneic cats (101 cardiac)	Reliable discrimination between cardiac and respiratory causes of dyspnea: cut-off 207 pmol/L, AUC 0.98 <sup>‡</sup>	Fox <sup>‡</sup>



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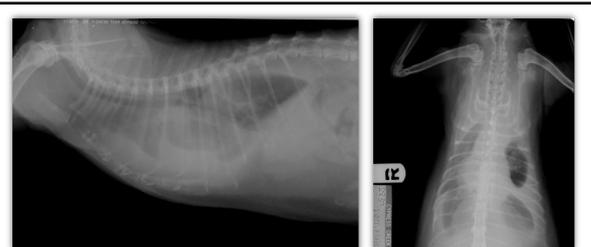
99

- Limited value as a screening tool
  - Arrhythmias are not common
  - Detected on physical examination
- Useful when arrhythmia ausculted
- Many non-cardiac causes for arrhythmias
- More useful when combined with imaging




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- Good screening tool
  - Readily available, cost effective, noninvasive
- Best way to diagnose CHF
- Abnormal radiograph suggestive of disease
  - Prompt additional diagnostics - Echocardiogram
- Limitation with feline cardiomyopathy
  - Lacks ability to assess function
  - Cannot measure wall thickness
  - Cannot discriminate between types of CM




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- Definitive diagnostic test
  - Essential for cardiomyopathy
- Cardiac function and chamber dimensions
- Gold standard
  - Establish diagnosis/estimate severity
- Drawbacks
  - Limited availability
  - Cost considerations
  - **Tremendous** user dependence




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### ARTERIAL THROMBOEMBOLISM

- Uncommon, but devastating
- Aortic bifurcation (usually)
  - Acute rear limb paralysis
  - Right forelimb
- Intensely painful

May develop clots in other organs  
Brain  
Kidney  
GI tract




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### DMVD



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<http://speakingforspot.com>

[http://int-prop.if2.cuni.cz/heart\\_sounds/h14/sound.htm](http://int-prop.if2.cuni.cz/heart_sounds/h14/sound.htm)



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Synonymous with:

- Degenerative mitral valve disease
- Myxomatous valvular degeneration
- Atrioventricular valvular insufficiency (AVVI)

Mitral valve

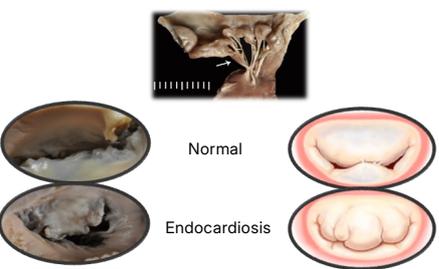
- Most common valve affected
- Mitral regurgitation → volume load

Tricuspid valve

- Rarely alone
- Often in conjunction with mitral valve
- Tricuspid regurgitation → volume load




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Normal

Endocardiosis



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Myxomatous degeneration	Interferes with normal coaptation	Valve prolapse
Mixture of degenerative and proliferative changes Thickened valve, redundant tissue Weakening of chordae tendinae	Allows for valve insufficiency/regurgitation	Contributes to valve regurgitation Creates valve buckling → midsystolic click

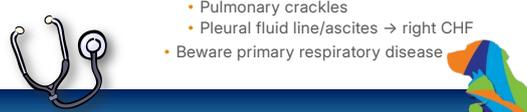


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Category	A	B	C	D
Category	No heart disease present	Heart disease exists B1: no remodeling B2: cardiomegaly	Heart disease with CHF	Refractory/complicated CHF
Example	At-risk animals: Dobermans, Cavaliers, Boxers	B1: mitral valve disease w/o enlargement. B2: occult DCM, MVD w/ LV/LA enlargement or pulmonary hypertension	MVD or DCM with pulmonary edema, ascites, or pleural effusion	CHF with atrial fibrillation, systemic hypotension (shock), pulmonary hypertension, or CHF refractory to standard diuretic doses
Treatment	None Nutritional supplements controversial	B1: none B2: controversial—Cardioprotection (ACEi/β-blockers/Spirolactone), Vetmedin Nutritional supplements	Triple therapy: • Lasix • ACEi • Vetmedin +/- spironolactone Nutritional supplements? Diet? β-blockers?	Heart rate control (digoxin, β-blockers, diltiazem), afterload reducers (amlodipine, hydralazine), inotropes (dobutamine, dopamine)

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- Almost exclusively occurs in dogs
  - Not reported in cats (possible if old enough)
- Signalment **critically** important
  - Older, small breed dogs
  - Large breed dogs
    - Not tolerated as well
    - Systolic dysfunction
      - Can mimic DCM
      - Valves not as thick
  - Left apical systolic murmur
    - May have palpable thrill = (V/VI)
  - Majority are asymptomatic
  - Signs of heart failure
    - Respiratory distress
    - Pulmonary crackles
    - Pleural fluid line/ascites → right CHF
  - Beware primary respiratory disease



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### Mitral valve disease in dogs (SMALL BREEDS)

Annular dilation occurs secondary to mitral regurgitation and causes lack of coaptation

Anterior leaflet prolapse is seen more commonly (48 % anterior, 7% posterior and 44% bileaflet) [Terzo et al, 2009]

16 % ruptured chordae in DMVD ( most commonly seen with severe) [Serres et al. 2007]



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### Mitral valve disease in dogs (LARGE BREEDS)

Mitral valve disease features absent or low intensity murmur, less pronounced morphologic changes of the valve, more pronounced and earlier onset systolic dysfunction, frequent rhythm abnormalities (atrial fibrillation) [Haggstrom and Borgarelli et al. 2004]

**PRIMARY VS. SECONDARY?**



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- Murmur on physical
- Likely asymptomatic
  - Annual wellness
  - Pre-anesthetic evaluation
- Coughing
  - Generally not cardiac → 1° respiratory disease
- Radiographs often normal
  - Minimal left atrial enlargement




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**Initial stage**

- Small volume
- Not hemodynamically significant

**Compensatory phase**

- Decreased stroke volume
- Compensate with RAAS/SNS
- Cardiac enlargement, increased contractility

**Decompensation**

- Regurgitation becomes excessive
- Fluid retention to maintain CO
- Volume overload → CHF



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### MISCONCEPTIONS IN MITRAL VALVE DISEASE

1. Physical exam is diagnostic of severe mitral regurgitation
2. Echocardiography is highly accurate in mitral regurgitation grading
3. Failing left ventricle is identified in chronic disease by low LV ejection fraction



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### Echocardiography

- Color Doppler methods
  - Jet measurements
  - Vena contracta
  - PISA
- CW and PW
  - Systolic flow reversal (pulmonary veins)
  - Volumetric estimates of regurgitant volume
  - EROA
  - Duration of MR jet
- Subjective structural changes: thickening, leaflet prolapse
- Remodeling:
  - LA dilation
  - Changes in LV dimensions
- Systolic and diastolic changes
- Pressure changes
  - Pulmonary hypertension
  - Ventricular filling pressures



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### Identified negative prognostic factors in dogs

Cardiac related deaths

- LA/Ao ratio > 1.4 in B1 and B2 [Borgarelli et al, 2012]
- LA/Ao ratio > 1.7 in symptomatic dogs [Borgarelli et al, 2008]

Left heart chambers increase rapidly in the year preceding decompensation [Lord et al, 2010]



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### COMPENSATED

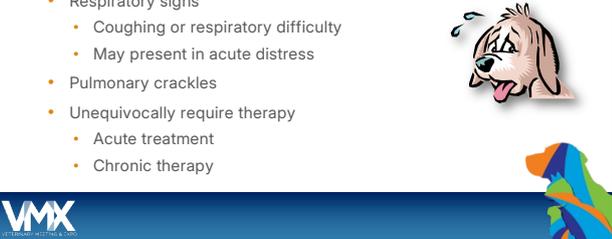
- Murmur generally loud
  - May be heard on right
- Coughing
  - Not in heart failure
- Radiographic changes
  - Left atrial and left ventricular enlargement
  - Evidence of airway compression
  - **No** pulmonary edema
- Treatment dilemma



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### DECOMPENSATED

- Congestive heart failure
- Respiratory signs
  - Coughing or respiratory difficulty
  - May present in acute distress
- Pulmonary crackles
- Unequivocally require therapy
  - Acute treatment
  - Chronic therapy



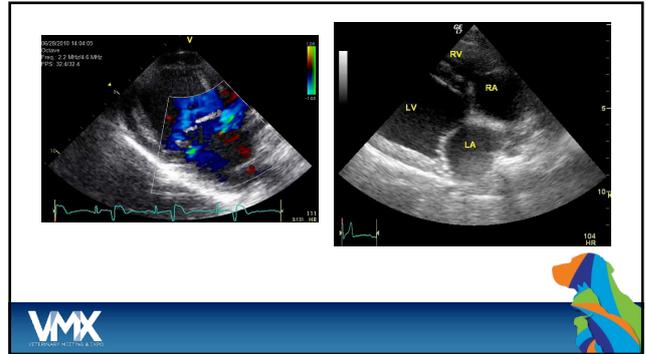
124




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**ADDITIONAL SEQUELAE**

- Left atrial split
  - Hemorrhagic pericardial effusion
  - Acute presentation → collapse
- Pulmonary hypertension
  - Not uncommon
  - Can cause respiratory distress and syncope
- Chordae tendinae rupture
  - Acute respiratory distress → fulminant CHF
  - Rare

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**LEFT ATRIAL SPLIT**

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**PULMONARY HYPERTENSION**

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2023

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