

Update on the Management of degenerative valve disease and congestive heart failure



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Outline

- Definitions and conceptual framework for managing canine heart disease and failure
- Basic physiology and cardiac drug review
- Staging degenerative valve disease for diagnostics and treatment
- Client education and follow up
- Case studies



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Heart Disease

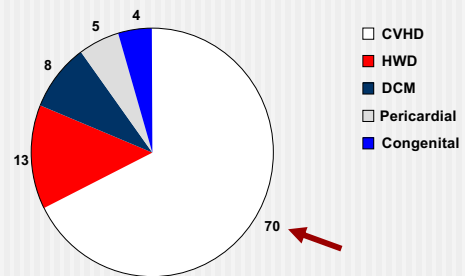
- The presence of a structural abnormality of the heart
- Depending on its nature and severity, heart disease may or may not cause heart failure



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Heart Disease in Dogs



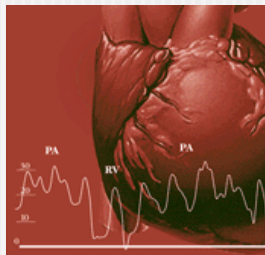
CVHD, chronic valvular heart disease; HWD: heart worm disease; DCM, dilated cardiomyopathy.

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Heart Failure (HF)

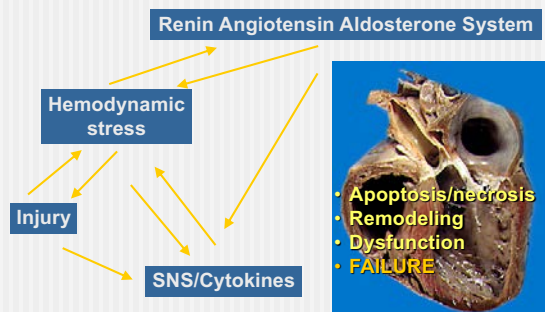
- HF is a complex clinical syndrome that can result from any structural or functional cardiac disorder that impairs the ability of the ventricle to fill with or eject blood
- HF results when the heart cannot pump enough blood to meet tissue needs at normal venous pressures



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Heart Failure Cascade



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ACC/AHA Classification of Heart Failure

- At risk for heart failure
 - **STAGE A** No structural disease, but high risk for developing heart disease
 - **STAGE B1** Asymptomatic disease, no cardiac remodeling
 - **STAGE B2** Asymptomatic disease, cardiac remodeling
- Heart failure
 - **STAGE C** Past or current signs/symptoms of HF
 - **STAGE D** End stage HF, signs refractory to Rx

J Am Coll Cardiol. 2001;38:2101-2113.

Canine Heart Failure

Stage A High risk No known injury No clinical signs	Stage B1+B2 Structural injury No clinical signs	Stage C Structural injury Current or Past clinical signs	Stage D Structural injury Refractory signs

Sites for pharmacologic intervention

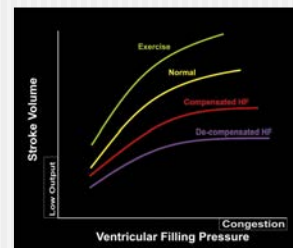
- Preload
- Afterload
- Contractility
- Heart rate



$$\text{Cardiac output} = \frac{\text{preload} \times \text{contractility} \times \text{HR}}{\text{afterload}}$$

Preload

The stretch of the left ventricle just before the onset of contraction (i.e. *end-diastolic volume*).



Preload reducers

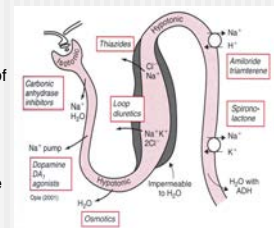
- Diuretics
 - **Furosemide**
 - Hydrochlorothiazide
 - Spironolactone
- Venodilators
 - nitroglycerine



Diuretics

Three major groups of diuretics used for HF—

- Loop Diuretics (ascending loop of Henle)
- Thiazide Diuretics (early distal tubule)
- Potassium sparing /aldosterone antagonist diuretics (distal tubule and collecting duct)



Furosemide: Indications & Pharmacologic Properties

- Mechanism – decreases PRELOAD
 - **Initial therapy in acute pulmonary edema**
- IV vs. oral:
 - Diuresis begins 5-20 min after IV dose
 - Oral onset 60 mins
 - IV dose peaks at 30 mins
 - Peak effects occur in 1-1.5 h following oral dose
 - IV duration is 2 hours
 - Duration 4-6 hours

Furosemide Dose range for cats and dogs

- Dogs
 - Most common dose: 1-2 mg/kg q12-8 hours
 - Titrate dose to affect
 - Can give 8-10 mg/kg in 1-2 mg/kg doses hourly in acute cases
- Cats
 - 1 mg/kg q 12 hours
 - Titrate dose to affect
 - Can give 6-8 mg/kg in 1-2 mg/kg doses hourly in acute cases, but significant azotemia risk

If clinical signs are present with a total daily dose of >6 mg/kg furosemide, alternative preload reducers may be necessary: **Furosemide refractoriness**

Afterload



The load against which the ventricle contracts, i.e. the *resistance to the ejection of blood from the ventricle (myocardial wall stress)*.

Determined by:

- Peripheral resistance (blood pressure)
- Heart size (chamber size/wall thickness)

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Afterload reducers

- Arteriodilators
 - ACE inhibitors
 - Pimobendan
 - Nitroprusside
 - Hydralazine



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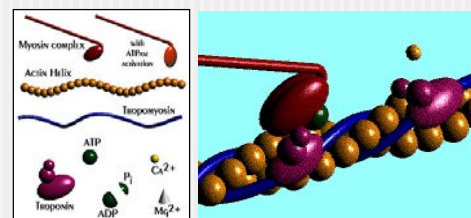
ACE Inhibitors: Indications

- All cause congestive heart failure
- No benefit in compensated valvular heart disease, regardless of left atrial size
- Unknown benefits in feline cardiomyopathies (DCM, HCM, UCM, etc)

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Myocardial Contractility

*Strength of the cardiac muscle contraction (systolic function).
At the molecular level, contractility is a load-independent interaction between calcium ions and the contractile proteins.*



Contractile Machinery	Regulatory Machinery	Requirements
Actin and Myosin	Troponin and Tropomyosin	ATP and Ca ²⁺

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Positive inotropes

- Pimobendan
- Dobutamine
- Digoxin



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Pimobendan

Dual Mode of Action ("Inodilation")

Increased contractility

- Calcium sensitizer
- Promotes efficient use of existing calcium
- Increases force of contraction
- Does not increase myocardial energy requirements

Balanced vasodilation

- Phosphodiesterase III inhibitor
- Dilates both arterial and venous vessels
- Reduces preload and afterload

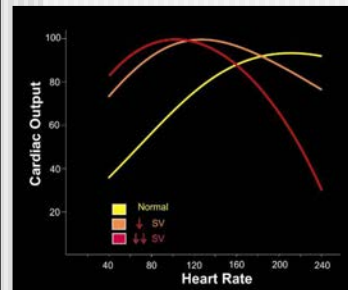
Pimobendan

- Rapid absorption
 - Mean peak plasma levels achieved 0.5-1.0 hour after administration of a single oral dose
- Indication
 - Management of the signs CHF in dogs due to degenerative valve disease or dilated cardiomyopathy in addition to other appropriate therapy
- Dose rate
 - 0.23 mg/lb (0.5 mg/kg) per day, in two divided doses that are not necessarily equal

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Heart Rate: Limitations



- Inverse force-frequency relationship
- Impaired Diastolic Filling due to elevated HR

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Negative chronotropes (supraventricular)

- Digoxin
- Beta blockers
 - Atenolol, metoprolol, sotalol
- Calcium channel blockers
 - Diltiazem



“Guidelines Should Come With an Expiration Date, Because They Are a Record of the Past.”

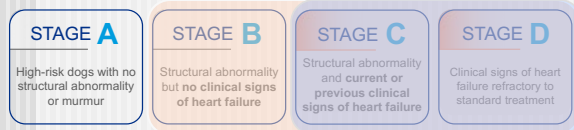
Warren Warwick, MD

Director, University of Minnesota
Cystic Fibrosis Center

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ACVIM classification of CHF

2009 Guidelines—
Specialty of Cardiology Consensus Panel of
the ACVIM¹



Heart disease

Heart failure

Consensus recommendations for stage A (degenerative valve disease)

- No drug therapy recommended
- No dietary recommendations
- Potential breeding considerations

Diagnostic Recommendations¹

STAGE B

Small breed dogs with murmurs

- ❏ Essential Diagnostics: Baseline radiograph with VHS
- Baseline blood work
- Blood pressure

ACVIM classification of CHF

STAGE B

Dogs with murmurs that have not yet developed clinical signs of CHF

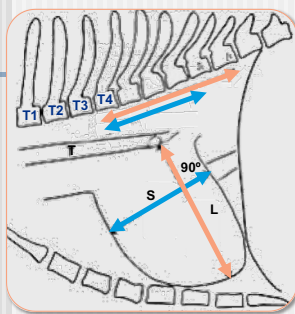
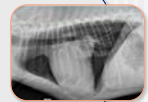
STAGE B1

No cardiac enlargement



STAGE B2

Cardiac enlargement present



CANINE VERTEBRAL HEART SCORE

$$\begin{aligned} \text{VHS} &= \text{L} + \text{S} \\ \text{VHS} &= 6 + 4.5 = 10.5 \\ \text{Normal} &= 8.7-10.7 \end{aligned}$$

Baseline Bloodwork¹

❏ Basic laboratory work includes a minimum of

- Hematocrit
- Total protein concentration
- Serum creatinine concentration and
- Urinalysis

❏ Baseline parameters will

- Give you a reference point for hydration and renal function and
- Concurrent diseases and therapy may effect these values
 - Eq. Diuretics and specific gravity

Blood Pressure Monitoring Recommendations

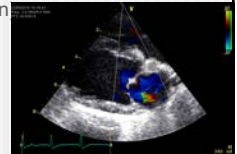
Why Monitor?

- ♥ Rule out systemic hypertension
 - From concurrent renal disease
- ♥ Progression of disease
 - Increases afterload
 - Increases regurgitation
- ♥ Systemic hypertension is controllable



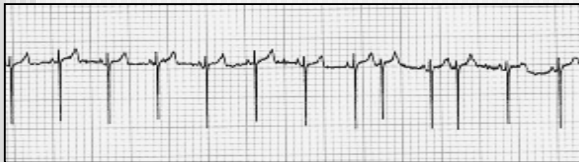
Benefits of echocardiography

- Atypical disease (unusual breed or murmur; heart enlargement pattern)
- Confirming whether dog meets EPIC criteria
- Presence of co-morbidities



Baseline ECG- *No consensus*

- ♥ Determine Heart Rate
- ♥ Rhythm – regular vs irregular
- ♥ Can suggest enlargement patterns
 - Thoracic radiographs are definitive tool for enlargement patterns



Consensus recommendations for stage B- **Therapy** (DVD)

- B1 (hemodynamically insignificant MR)
 - No drug or dietary recommendations
 - Re-evaluation with radiographs or echocardiography at least yearly
- B2 (hemodynamically significant MR)
 - According to the EPIC trial, starting pimobendan resulted in an average extension of 15 months to heart failure
 - Re-evaluation with physical examination +/- radiographs or echocardiography every 6 months

Client Education

- ♥ Educate the client about
 - Identify early warning signs
 - Coughing, changes in breathing pattern, sleep behavior
 - Demonstrate obtaining a respiratory rate and suggest they begin keeping a log of their findings at home.
 - Establish a baseline for normal and give them a cut off
 - Monitor weekly once a patient is B2
 - Omega 3 fatty acid supplementation

Consensus recommendations for stage C- **Diagnosis** (DVD)

- Thoracic radiography, echocardiography, basic laboratory testing
 - Echocardiography once patient is stable
- No consensus about BNP testing

Consensus recommendations for stage C- Therapy (DVD)

- Acute CHF
 - **Furosemide** (1-4 mg/kg with dose depending on severity of clinical signs and response)
 - **Pimobendan** (0.25-0.3 mg/kg PO q12h)
 - **Oxygen** supplementation
 - Mechanical treatments (i.e. thoracocentesis, etc)
 - Optimal nursing care
 - Sedation if indicated (Butorphanol-0.2-0.25 mg/kg IM or IV)
 - Nitroprusside for poorly responding patients

Consensus recommendations for stage C- Therapy (DVD)

- Chronic CHF (home based therapy)
 - Continue oral **furosemide** (1-3 mg/kg q 6-12 h; use the lowest effective dose)
 - Continue or start ACEI (**enalapril** 0.5 mg/kg q12h)
 - Continue **pimobendan** (0.25-0.3 mg/kg PO q12h)
 - Participation in a structured, home based extended care program
 - Aggressive management of anorexia or weight loss to avoid cardiac cachexia
 - Modest salt restriction
 - Monitor serum potassium

Consensus recommendations for stage D- Diagnosis (DVD)

- By definition stage D heart failure patients are refractory to treatments for stage C.
- Diagnostic steps are similar to those for stage C

Consensus recommendations for stage D- Therapy (in addition to those drugs started under stage C)

- Acute
 - In the absence of severe renal failure, increase **furosemide** dose as needed
 - Fluid removal
 - **Oxygen** supplementation; mechanical ventilation may be useful in some patients
 - More vigorous afterload reduction
 - Nitroprusside, hydralazine, amlodipine

Consensus recommendations for stage D- Therapy (in addition to those drugs started under stage C)

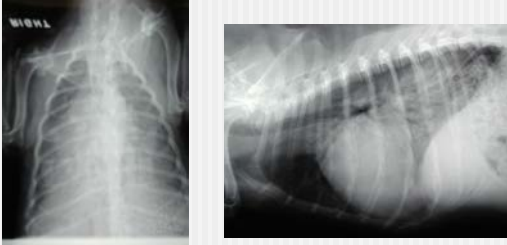
- Chronic (home based therapy)
 - In the absence of severe renal failure, increase **furosemide** dose as needed
 - **Spirolactone** if not already started
 - Consider triple diuretic therapy
 - Furosemide, hydrochlorothiazide, spironolactone
 - Beta blockade should not be initiated unless clinical signs of CHF are controlled
 - More vigorous afterload reduction
 - **Hydralazine**, **amlodipine**
 - Same dietary recommendations as stage C

George

- 9-year-old male Miniature Poodle
- 6 month history of a systolic left apical murmur
- 1 week history lethargy and exercise intolerance
- 12 hour history difficulty sleeping and breathing



George Radiographs



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George Acute Therapy

- Preload reduction
- Increase contractility (positive inotropes)
- Afterload reduction (arterial dilators)

**Furosemide, oxygen therapy, +/-
pimobendan or dobutamine**

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George Chronic Therapy

- Furosemide
- ACEI (enalapril)
- Pimobendan
- Owner education: respiratory log; etc.
- Renal panel in 7-10 days
- Add in spironolactone at 6 month recheck (or sooner if recurrence of CHF)

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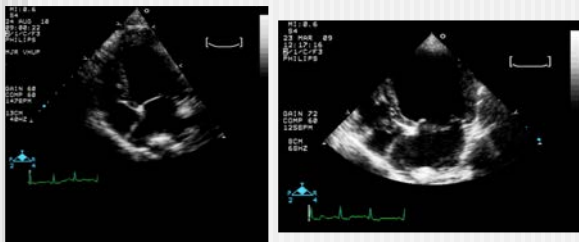
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George echocardiogram



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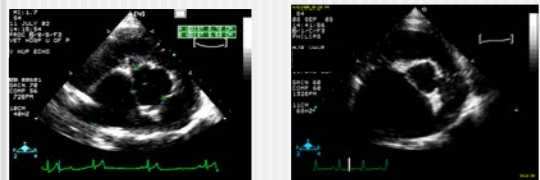
George echocardiogram



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George echocardiogram



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Additional drugs in the arsenal

- Preload reducers
 - Hydrochlorothiazide
 - Spironolactone
- Afterload reducers
 - Amlodipine
- Heart rate control
 - Digoxin
 - Dilatiazem
 - Beta blockers- atenolol

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Questions?



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Thor

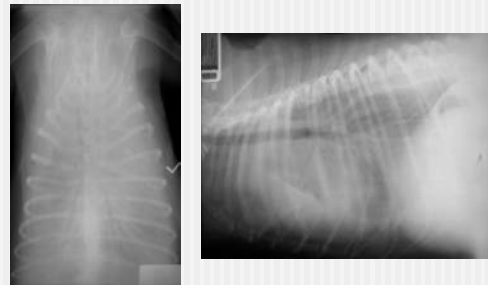
- 4-year-old male Great Dane
- Lethargy, exercise intolerance x 1 wk
- Difficulty sleeping and breathing x 12 hours
- No cough reported
- Rapid, irregular heart sounds w/ pulse deficits
- Tachypnea/dyspnea



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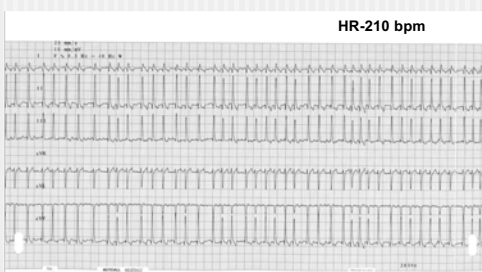
Thor Radiographs



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Electrocardiogram



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Thor echocardiogram



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Thor

Acute Therapy

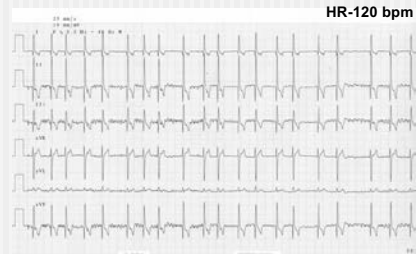
- Thoracocentesis for removal of fluid
- Preload reduction
- Heart rate/rhythm management
- Increase contractility (positive inotropes)
- Afterload reduction (arterial dilators)

- Thor's immediate plan: **thoracocentesis**

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Electrocardiogram post tap



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Thor

Chronic Therapy

- Furosemide
- ACEI (enalapril)
- Pimobendan
- +/- Digoxin and/or diltiazem
- Owner education: respiratory log; etc.

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At home management of heart failure patients: tips and tricks for clinicians and clients

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Once patient is in stage C of disease

- Once in stage C begin triad of heart failure medications
 - Pimobendan
 - Furosemide
 - ACE inhibitor
 - +/- spironolactone
- Titrate furosemide to the lowest possible dose that controls clinical signs (importance of respiratory log); generally not less than 1 mg/kg twice daily
- Furosemide forms: 12.5, 20, 40, 50, 80 mg tablets; 10 mg/mL elixir
- "Lasts 6 hours"
- Importance of monitoring renal function
 - Renal panels (SG is no longer useful)
 - Appetite changes

Dealing with furosemide refractoriness

- Use injectable (SQ) furosemide
- Triple diuretic therapy (add hydrochlorothiazide and spironolactone or aldactazide) CAUTIOUSLY
 - Hydrochlorothiazide: 2-4 mg/kg S-BID
 - Spironolactone: 1-2 mg/kg S-BID
- Torsemide
- Importance of renal function monitoring

Torsemide

- Loop diuretic with longer duration of action and decreased susceptibility to resistance than furosemide
- Aldosterone antagonistic effects
- Dose: 1/10 daily furosemide divided into 2 doses per day

Compounding medications

- Transdermal cardiac medications generally cannot be measured systemically and are not recommended
- Combining multiple medications into one liquid medication or tablet
 - Possible loss of efficacy
 - Ease of administration
 - Less confusing for owners

Resting respiratory log book

- RR has been shown to be one of the most effective ways to identify early heart failure in human cardiac patients
- When utilized correctly, they:
 - Reduce hospitalizations
 - Decrease owner financial and emotional fatigue
 - Reduce episodes of fulminant heart failure
 - Cardiac cell death accelerates with the hypoxia associated with overt heart failure. The number of heart failure episodes has been linked to more rapid progression of heart disease in humans.

Dealing with coughing

- Cough is very uncommonly associated with heart disease in cats
- In dogs with valve disease, coughing is more likely to be associated with tracheitis than congestive heart failure, particularly if RR is normal
 - Benefit of owners maintaining a respiratory log
- Options for severe tracheitis cases:
 - Hydrocodone
 - Butorphanol
 - Diphenoxylate/Lomotil
 - Maropitant/Cerenia
 - Prednisolone (cautiously)
 - Fluticasone



Systemic blood pressure monitoring

Why Monitor?

- Systemic hypertension is often silent and older dogs are at risk of developing it
- Because it results in increased afterload, it increases the cardiac workload and may speed the progression of heart disease
- Systemic hypertension is controllable
- Further diagnostics warranted to identify cause if present (renal disease)

Tips for Measuring Blood Pressure

- ♡ Patient positioning is essential
 - Lateral recumbency vs. sternal recumbency
 - Use the up leg
 - Base of tail
- ♡ Choose an appropriate cuff size
- ♡ Average of three measurements

Note: Each time you take a BP be consistent in patient positioning and cuff size. Record each piece of information when you record the BP.

Monitoring heart rate

- Atrial fibrillation, feline cardiomyopathy
- The optimal heart rate goal for dogs with atrial fibrillation and severe heart disease is poorly defined
 - Some authors have suggested < 140 bpm while others target 90-110 bpm
- Monitoring the heart rate at home is critical to good heart rate control (many dogs with atrial fibrillation require both diltiazem and digoxin for good heart rate control)
- Methods to monitor heart rate at home
 - 24 hour Holter monitor
 - Auscultation
 - Heart rate monitor
 - AliveCor
 - Voyce



24 hour Holter monitor

- Gold standard for heart rate assessment
- Allows evaluation of exercising and sleeping heart rate
- Expense of repeated Holters



Auscultation

- Simple and inexpensive
- Auscultatory estimates of heart rate (particularly in A Fib) may be significantly inaccurate
- Snap shot heart rate assessment
 - Impossible to measure exercising heart rate or accurately assess the presence of pauses in heart rhythm

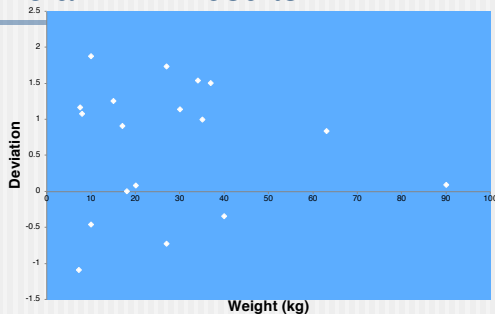


Heart rate monitor

- Designed for measuring heart rates in horses (hand held device counts HR for 6 sec; upper limit of 200 bpm)
- Within 10% of ECG calculated HR in most of 18 dogs (body wts 5-50 kg) including 6 with A Fib
 - Easiest and most accurate in large dogs
- Snapshot heart rate assessment
- Can be purchased through Polar or various equestrian tack shops



Polar HRM results



Alivecor

- Device can be used with iPhone
- Heart rate and rhythm monitoring
- Data can be saved as a pdf and forwarded
- Snap shot heart rate and rhythm assessment



Voyce Health Monitor

- Monitor worn as a collar that tracks various parameters
 - Resting heart rate
 - Resting respiratory rate
 - Activity intensity
 - Calories burned
 - Distance travelled
 - Quality of rest



Dietary considerations

- Avoid cachexia and obesity
- Monitor potassium and magnesium serum levels
 - Supplementation with potassium and/or magnesium on case by case basis
 - Particularly in patients with **cardiac arrhythmias**
- Omega-3 Fatty Acid
 - 180 mg eicosapentaenoic acid/120 mg docosahexaenoic acid; 1 per 10 pounds BW

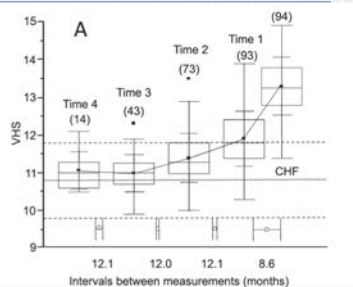
Minimize routine re-checks

- Requires appropriate use of respiratory log
- Benefits
 - Decrease owner financial fatigue
 - Decrease risk of decompensation in a fragile patient
- In reality, with the vast majority of dogs and cats, we are treating congestive heart failure rather than the underlying heart disease

Use of thoracic radiographs

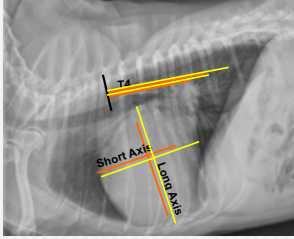
- Cost effective method for staging disease
- Vertebral heart size (VHS) is an objective method to serially evaluate heart size changes
- Good screening method for identifying cause of dyspnea in cats
- In the months prior to the development of congestive heart failure, the VHS increases more rapidly in dogs
- Effective for dogs and cats with minimal inter-observer variability in multiple studies
 - Breed variability

J Fm Res Med Biol 2012;1(1):1-10
Radiographic Heart Size and Its Rate of Increase as Tests for Onset of Congestive Heart Failure in Cavalier King Charles Spaniels with Mitral Valve Regurgitation
 P.F. Lord, K. Hanson, C. Cornehoi, C. Kruze, and J. Higginson



Breed	R or L	VHS	SD	n	Reference
Various Breeds	L	9.54	0.6	85	19
Various Breeds	R	9.8	0.6	85	19
Various Breeds	-	9.7	0.5	100	2
Yorkshire Terrier	R	9.7	0.5	22	7
German Shepherd	R	9.7	0.8	20	7
Turkish Shepherd	L	9.7	0.87	100	15
Rotweiler	-	9.8	0.1	38	16
Cavalier King Charles Spaniel	-	9.8	-	12	10
Doberman pinscher	R	10.0	0.8	20	7
Doberman pinscher	L	10.05	-	10	10
Doberman pinscher	R	10.33	-	10	10
Various large breeds	-	10.1	0.2	16	16
Poodle	R	10.1	0.5	23	11
Beagle	L	10.2	0.4	19	18
Beagle	R	10.5	0.4	19	18
Greyhound	-	10.5	0.1	42	16
Cavalier King Charles Spaniel	R	10.6	0.5	20	7
Cavalier King Charles Spaniel	-	10.8	0.5	10	12
Labrador Retriever	R	10.8	0.6	25	7
Cocker Spaniel	L	10.94	-	10	10
Cocker Spaniel	R	11.05	-	10	10
Whippets (show pedigree line)	L	10.5	0.6	8	14
Whippets (show pedigree line)	R	10.8	0.6	8	14
Whippets (racing pedigree line)	L	11.1	0.4	32	14
Whippets (racing pedigree line)	R	11.4	0.4	32	14
Boxer	L	10.89	-	10	10
Boxer	R	11.51	-	10	10
Boxer	-	11.6	0.8	20	7

Assessment of Cardiac Size



Long Axis Line (5.2)
Short Axis Line (4.4)

Normal VHS < 10.5 – 11.0

This VHS = 7.2 + 6.4 = 13.6

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VHS, vertebral heart size

Questions?

