



## Surgical Meeting

### Cardiorespiratory focus



## How to treat...

# Acute Heart Failure

Carlos F. Agudelo  
VFU – Brno

## Heart disease

**Heart failure** is the beginning of symptoms of inefficiency of compensatory mechanisms.

- Exercise intolerance
- Syncope
- Cough
- Ascites

**Congestive heart failure** (CHF) is the development of congestion of the organs upstream of the insufficient heart chamber. Also known as **backward heart failure**.



## Congestive Heart Failure

**\*\*Left-sided CHF:**

- pulmonary edema

**\*\*Right-sided CHF:**

- pleural effusion (can occur in cats with left-sided CHF and is often chylous)
- pericardial effusion
- ascites
- organomegaly



## Congestive Heart Failure

### Systolic dysfunction

DCM, valvular insufficiency, A/V shunts, hypertension (primary - secondary), arrhythmia.

### Diastolic dysfunction

HCM, pericardial disease.



## Congestive Heart Failure - DMVD

### Guidelines for the Diagnosis and Treatment of Canine Chronic Valvular Heart Disease

J Vet Intern Med 2009;23:1142-1150  
C. Atkins, J. Bonagura, S. Ettinger, P. Fox, S. Gordon, J. Haggstrom, R. Hamlin, B. Keene (Chair), V. Luis-Fuentes, and R. Stepien

### Pharmacologic management of myxomatous mitral valve disease in dogs

Journal of Veterinary Cardiology (2012) 14, 165-184

Clarke E. Atkins, DVM <sup>a,\*</sup>, Jens Häggström, DVM, PhD <sup>b</sup>



## Congestive Heart Failure - DMVD

Group	Description	ISACHC
A	Patients at risk (i.e. CKCHS, poodle, etc.) / breeding program	Ia
B	Patients with a murmur without clinical signs	
B1.	Hemodynamically unimportant regurgitation (no signs of radiographic / echocardiographic remodeling)	Ia
B2.	Hemodynamically important regurgitation (radiography / echocardiography signs of cardiomegaly)	Ib



## Congestive Heart Failure - DMVD

Group	Description	ISACHC
C	Past or present signs of heart disease	
	C1 - Acute (hospitalization)	IIIb
	C2 - Chronic (outpatient)	II
D	Terminal disease - signs refractory to „standard therapy“	
	D1 - Acute (hospitalization)	IIIb
	D2 - Chronic (outpatient)	IIIa



## Congestive Heart Failure - DMVD

### Asymptomatic patient (group A). Consensus

- Without therapy. Yearly auscultation.

### Asymptomatic patient (group B1). Consensus

- No therapy.
- Repeat examination (blood work, RTG, EKG, echo, BP) after 6 months.
- Giving medications to this group *might* interrupt compensatory mechanisms and accelerate progression.



## Congestive Heart Failure - DMVD

### Asymptomatic patient (group B2).

ACE inhibitors: **NO consensus**

Enalapril: 0,25-0,5 mg/kg PO, BID (cats SID-QOD)

Benazepril: 0,25-0,5 mg/kg PO, SID-BID (cats: max. 2,5 mg/daily)

Imidapril: dogs: 0,25-0,5 mg/kg PO, SID

Ramipril: dogs: 0,125-0,25 mg/kg PO, SID

Lisinopril\*: 0,25-0,5 mg/kg PO, SID.BID

\*liver disease.



*J Vet Intern Med* 1998;12:93-95

Comparison of Some Pharmacokinetic Parameters of 5 Angiotensin-Converting Enzyme Inhibitors in Normal Beagles

Robert L. Hamlin and Tomohiro Nakayama



## Congestive Heart Failure - DMVD

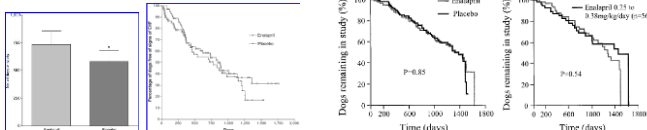
### Asymptomatic patient (group B2).

*J Am Vet Med Assoc* 2007;231:1061-1069  
**Results of the veterinary enalapril trial to prove reduction in onset of heart failure in dogs chronically treated with enalapril alone for compensated, naturally occurring mitral valve insufficiency**

Charles E. Adams, DVM, MS, DACVIM, DACVIM (Card), DACVIM (Small Animal); William A. Brown, DVM, MS, DACVIM (Card); Mary Ann Crandall, DVM, DACVIM, DACVIM (Card); Debra L. DeFrancesco, DVM, DACVIM (Card); Scott E. Fubini, DVM, DACVIM (Card); Phillip H. Fox, DVM, DACVIM (Card); Elizabeth A. Gruffydd-Jones, DVM, DACVIM (Card); Michael W. Lumb, DVM, DACVIM (Card); Kathleen M. Mease, DVM, DACVIM (Card); Jean-Paul Pons, DVM, DACVIM (Card); Frank S. Piper, DVM, DACVIM (Card); Sherrie L. Rosenthal, DVM, DACVIM (Card); Jeffrey S. Suter, DVM, DACVIM (Card); Susan M. Weese, DVM, DACVIM (Card)

*J Am Vet Med Assoc* 2002;264:306-310  
**Efficacy of Enalapril for Prevention of Congestive Heart Failure in Dogs with Myxomatous Valve Disease and Asymptomatic Mitral Regurgitation**

Cherise Kiser, JMS; Hagarina, Hristi; Debra DeBorja, Proulx; Kerrie Hanson; Audrey Erikson; Anna-Karen Bryson; Anne Tolkman; Kristin Brooks; Erik Adgore; Mikael Pons; Britt-Marie; David Felt; Ellen Harkin; Suzanne Gaudin; Peter Lord; Gudrun Wegmann; Eva Ahlsson; and Jan Carlsson



## Congestive Heart Failure - DMVD

### Asymptomatic patient (group B2).

Other therapies

- Inodilators. **NO consensus**
- Beta-blockers. **NO consensus**
- Spironolactone. **NO consensus**



## Congestive Heart Failure - DMVD

*Symptomatic patient (group C).*

*Mild to moderate heart failure.*

### Outpatient vs. hospitalization

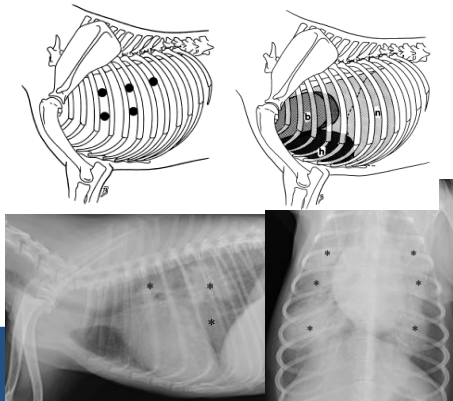
Outpatient with the exception of serious arrhythmia and/or pulmonary edema.



## Congestive Heart Failure



## Congestive Heart Failure



## Congestive Heart Failure - DMVD

### Hospitalized patient (C1 patients).

#### Initial stabilization. -Consensus-

\*Oxygen therapy (40-100% in cage, mask or nasal catheter during 24-48h).

\*Prevent hypothermia.

\*Give IV infusions (i.e. Ringer/Hartmann with glucose). Dose depends on the respiratory distress between 40-70 ml/kg/day.

\*Cage rest – use sedation if necessary



## Congestive Heart Failure - DMVD

### Hospitalized patient (C1 patients).

#### Patient with pulmonary edema:

1) Diuretics -Consensus-

-Furosemide: 2-6 mg/kg every ½ - 1 hour IV until improvement\*\*  
\*\*according to the clinical status: continue 1-3 mg/kg IV, TID-QID the first 2-3 days.

-CRI: 0,2-1 mg/kg/hr.

2) Inotropic support -Consensus-

Pimobendan: 0,1-0,3 mg/kg PO, SID-BID.



## Congestive Heart Failure - DMVD

### Hospitalized patient (C1 patients).

#### Patient with pulmonary edema – additional approaches:

1) Vasodilators - Nitrates.

a) Systemic administration: - not part of consensus, but accepted-  
Sodium nitroprussiate: 1-10 mcg/kg/min IV; monitor BP, max. 1-2 days.

b) Local application:

2% nitroglycerin: 0,6 cm/5 kg 3-4x daily. -NO consensus-

c) ACE inhibitors -NO consensus-



## Congestive Heart Failure - DMVD

### Hospitalized patient (C1 patients).

Patient with pulmonary edema – additional approaches:

- 1) Vasodilators.
  - d) Hydralazine **-NO consensus-** (amlodipine?)
- 2) \*Dobutamin: dogs, 1-10 µg/kg/min IV; cats, 1-5 µg/kg/min IV, max. 1-3 days. **-NO consensus-**
- 3) Bronchodilators
 

Aminophyllin: 4-6 mg/kg IV, TID the first 24-48h. **-NO consensus-**



## Congestive Heart Failure - DMVD

### Hospitalized patient (C1 patients).

Patient with pulmonary edema – additional approaches:

**Pleural effusion or ascites**  
Thoraco/abdominocentesis + diuretics.

**Arrhythmia.**  
Atrial fibrillation and ventricular premature complexes (VPCs) also in advanced stages.



## Congestive Heart Failure - DMVD

### Outpatients (C2 patients).

Use the "triple therapy" **-Consensus-**

- a. ACE inhibitors.
- b. Pimobendan: 0,1-0,3 mg/kg PO, SID-BID.
- c. Furosemide: 1-4 mg/kg PO, BID-TID



## Congestive Heart Failure - DMVD

### Outpatients (C2 patients).

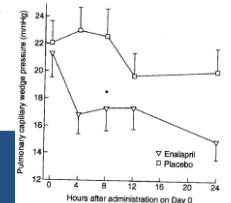
"The triple therapy" **-Consensus-**

ACE inhibitors.

*Journal of Veterinary Internal Medicine, Vol 9, No 4 (July-August), 1995; pp 234-242*  
**Acute and Short-Term Hemodynamic, Echocardiographic, and Clinical Effects of Enalapril Maleate in Dogs With Naturally Acquired Heart Failure: Results of the Invasive Multicenter PROspective Veterinary Evaluation of Enalapril Study**

The IMPROVE Study Group

- Lower pulmonary and systemic pressure
- Lower heart rate
- Lesser presentation of pulmonary edema



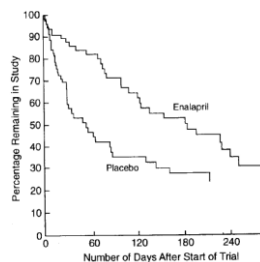
## Congestive Heart Failure - DMVD

### Outpatients (C2 patients).

"The triple therapy" **-Consensus-**  
ACE inhibitors.

**Effects of enalapril maleate on survival of dogs with naturally acquired heart failure**

*S. J. Eisinger, DVM, A. M. Benitz, DVM, MS, G. F. Ericsson, MS, S. Calzoli, BA, A. D. Jernigan, DVM, PhD, S. L. Longhofer, DVM, MS, W. Itabashi, BS, F. D. Hanson, DVM, PhD, for the Long-Term Investigation of Veterinary Enalapril (LIVE) Study Group*  
J Am Vet Med Assoc 1998;213:1573-1577



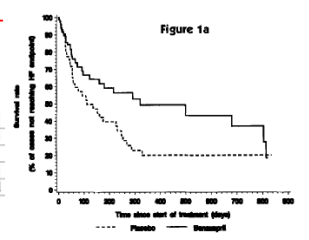
## Congestive Heart Failure - DMVD

### Outpatients (C2 patients).

"The triple therapy," **-Consensus-**  
ACE inhibitors.

*Journal of Veterinary Cardiology, Vol. 1, No. 1, May 1999*  
**The effect of benazepril on survival times and clinical signs of dogs with congestive heart failure: Results of a multicenter, prospective, randomized, double-blinded, placebo-controlled, long-term clinical trial**

The BENCH (BENazepril in Canine Heart disease) Study Group\*



## Congestive Heart Failure - DMVD

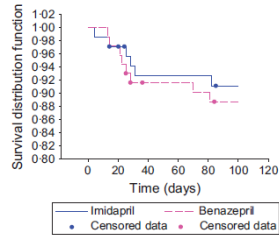
### Outpatients (C2 patients).

#### "The triple therapy"

ACE inhibitors.

#### Clinical evaluation of imidapril in congestive heart failure in dogs: results of the EFFIC study

B. BESCHE, V. CHETBOUL\*, M.-P. LACHAUD LEFAY AND E. GRANDEMANGE†  
Journal of Small Animal Practice (2007) 48, 205-210



## Congestive Heart Failure - DMVD

### Outpatients (C2 patients).

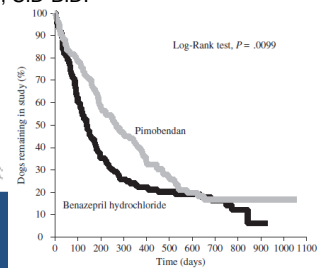
#### "Use the triple therapy" -Consensus-

Pimobendan: 0,1-0,3 mg/kg PO, SID-BID.

J. Vet Intern Med 2009;23:1124-1135

#### Effect of Pimobendan or Benazepril Hydrochloride on Survival Times in Dogs with Congestive Heart Failure Caused by Naturally Occurring Myxomatous Mitral Valve Disease: The QUEST Study

J. Haggstrom, A. Boswood, M. O'Grady, O. Jinn, S. Smith, S. Scott, M. Berglund, B. Garavito, J.-G. Krackel, M. Paterson, B. Abbat, C.M. Branson, T. Glass, A. Kowalewski, M. Rapp, R.A. Susskind, A. Tulluhn, A. Eriksson, M.C. Bideringer, M. Dimer, C.J.L. Little, C. Kurtz, A. Frisch, M. Ramo-Ladillo, G. Wess, A.V. Eggenstedt, M.L. O'Sullivan, M. Schneider, C.W. Lombardi, J. Dulcich-Melrose, R. Willis, A. Lomax, and R. DiFrancesco



## Congestive Heart Failure - DMVD

### Outpatients (C2 patients). NO CONSENSUS

#### 1) Positive inotropics

Digoxin: 0.005-0,01mg/kg PO, SID-BID (dogs >20kg: 0,22 mg/m<sup>2</sup>)

#### 2) Beta-blockers

#### 3) Calcium channel blockers

-Diltiazem (if atrial fibrillation present): 1 mg/kg PO BID  
-Amlodipine: 0,1 mg/kg PO SID

#### 4) Vasodilators

- Hydralazin: 0,5-2 mg/kg PO, BID.  
- Amlodipine: 0,1 mg/kg PO SID



## Congestive Heart Failure - DMVD

### Outpatients (C2 patients). NO CONSENSUS

#### 5) Other diuretics

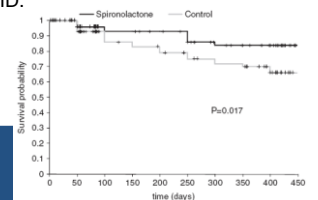
- Hydrochlorothiazide: 2-4 mg/kg PO, SID-BID (begin with 1/2 dose)

- Torsemide: 0,2 mg/kg IV, IM, SID-BID

- **Spirolactone** 1-2 mg/kg PO, SID.

#### Efficacy of Spirolactone on Survival in Dogs with Naturally Occurring Mitral Regurgitation Caused by Myxomatous Mitral Valve Disease

F. Bernay, J.M. Bland, J. Haggstrom, L. Balogh, B. Combes, A. Lopez, and V. Kallstas



## Congestive Heart Failure - DMVD

### Outpatients (C2 patients). NO CONSENSUS

#### 6) Bronchodilators

Theophyllin: 10 mg/kg PO, SID-BID.

#### 7) Cough suppressants

Hydrocodone: (dose?) 0,22 mg/kg PO, BID, QID.

#### Other recommendations

-Exercise restriction.

-Diet: decrease sodium intake (> 0,35% dry matter – commercial diets better).



## Congestive Heart Failure - DMVD

### Symptomatic patient (group D).

#### Refractory congestive heart failure (advanced).

- Most of patients are in critical stage and need hospitalization. Complications like arrhythmia and ventricular dysfunction can be present.

- O<sub>2</sub> therapy, warming, cage rest-sedation and infusion therapy are conditions.

- Centesis (tapping): ascites or pleural effusion.



## Congestive Heart Failure - DMVD

### Hospitalized patient (D1 patients).

#### Patient with pulmonary edema:

#### 1) Diuretics -Consensus-

Furosemide:

Bolus administration or CRI

#### 2) Inotropic support -Consensus-

Pimobendan: 0,1-0,3 mg/kg PO, SID-BID.



## Congestive Heart Failure - DMVD

### Hospitalized patient (D1 patients).

#### Patient with pulmonary edema:

#### 3) Vasodilators. -Consensus-

- Sodium nitroprussiate: 1-10 mcg/kg/min IV; max. 1-2 days.

- Hydralazine: 0,5-2 mg/kg PO BID

- Amlodipine: 0,1 mg/kg PO SID

#### 4) Increase inotropic support to contrarrest the hypotension

- Dobutamin: 2-15 µg/kg/min CRI -Consensus-



## Congestive Heart Failure - DMVD

### Hospitalized patient (D1 patients).

#### Patient with pulmonary edema **NO CONSENSUS**

#### 1) Vasodilators

- ACE inhibitors

- Nitroglycerin ointment: 0,6 cm/5 kg 3-4x daily

#### 2) Inotropic support (use alone)

- High dose pimobendan (i.e. 0,3 mg/kg PO, TID).

- Dobutamin: 2-15 µg/kg/min CRI.



## Congestive Heart Failure - DMVD

### Outpatients (D2 patients). **CONSENSUS**

#### 1) Diuretics

Furosemide 2-6 mg/kg PO BID-QID

Alone or in combination with...

\* Spironolactone 1-2 mg/kg PO SID.

\* Hydrochlorothiazide: 1-2 mg/kg PO, SID-BID (begin with ½ dose)

#### 2) Inotropic support.

- Pimobendan

#### 3) ACE inhibitors.

#### 4) Spironolactone.



## Congestive Heart Failure - DMVD

### Outpatients (D2 patients). **NO CONSENSUS**

#### 1) Digoxin

#### 2) Sildenafil

#### 3) Cough suppressants

Strict exercise restriction.

#### 4) Bronchodilators

Decrease sodium in diet.

#### 5) Amlodipine

#### 6) Torsemide

#### 7) Hydrochlorothiazide (alone)



## Congestive Heart Failure - DCM

### Group Description

**A** Asymptomatic – No evidence of occult form

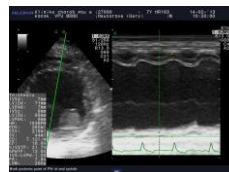
**B** **B1-** Preclinical DCM

**B2-** Arrhythmogenic DCM

Present or past signs of congestion

**C** **C1-** Acute (hospitalization)

**C2-** Chronic (outpatient)



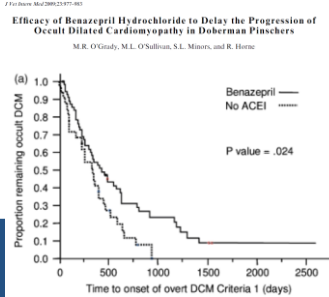
## Congestive Heart Failure - DCM

### Class A:

- Yearly echocardiographic examinations.
- Yearly Holter examinations.

### Class B:

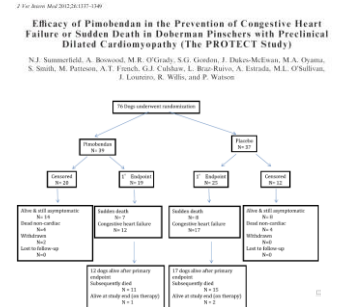
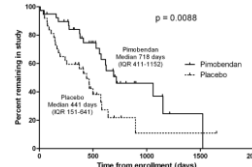
- B1 – preclinical**
- No treatment
- ACE-inhibitors (Benazepril)
- Beta - blockers



## Congestive Heart Failure - DCM

### Class B:

- B1 – preclinical**
- Pimobendan.



## Congestive Heart Failure - DCM

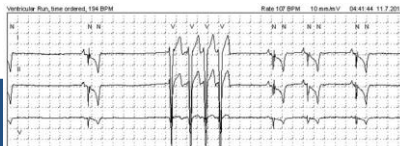
### Class B:

#### B2- arrhythmogenic form

-Sotalol: 2 mg/kg PO, BID (40-80 mg/dog) or in combination with mexiletin (5-8 mg/kg PO, BID-TID)

#### -Beta blockers

Atenolol: 0,75-1.5 mg/kg PO, BID (6,25-25 mg/dog PO BID)  
Metoprolol: 0,5-1 mg/kg PO, BID (12,5 mg/dog BID)



## Congestive Heart Failure - DCM

### Class C1:

#### Acute CHF

-Same recommendations as DMVD

-Give importance to the inotropic support and arrhythmia control.

### Class C2:

#### Chronic CHF

• Furosemide: 1-4 mg/kg PO BID-TID, increase as needed.

• Pimobendan (0,25 mg/kg PO, BID).

• ACE-inhibitors (0,5 mg/kg PO, BID).

• L-carnitine

## Congestive Heart Failure - DCM

### Class C2:

#### Chronic CHF

• Digoxin: slows HR via modulating neurohormones, central vagomimetic effect, normalizes baroreceptor dysfunction

• Beta-blockers or calcium channel blockers to lower HR.

• Spironolactone

• Other: hydrochlorothiazide, antiarrhythmics

## Congestive Heart Failure HCM

**Class A** - Asymptomatic cats without left ventricular hypertrophy

### Class B

**B1** Asymptomatic cats with left ventricular hypertrophy

**B2** Asymptomatic cats with left ventricular hypertrophy AND left atrial dilatation

**Class C** - HCM and congestive heart failure

**C1:** acute presentation

**C2:** outpatients

**Class D** - refractory HCM

## Congestive Heart Failure - HCM

### **Class A - Asymptomatic cats without left ventricular hypertrophy**

- Patients at risk
- No therapy

### **Asymptomatic cats with left ventricular hypertrophy (Class B1)**

•Nothing as there are no studies to date.

OR

•ACE inhibition - no difference in studies.

OR

•Diltiazem - improves early diastolic relaxation

OR

•Atenolol

HOWEVER

No benefits on 5 year survival in cats with preclinical HCM



EFFECTS OF ATENOLOL ON FIVE-YEAR SURVIVAL IN CATS WITH PRECLINICAL HYPERTROPHIC CARDIOMYOPATHY. K.E.S. Schober<sup>1</sup>, J. Zientek<sup>1</sup>, X. LF, V. Luis Fuentes<sup>1</sup>, D. Bonagura<sup>1</sup>. <sup>1</sup>The Ohio State University, COLUMBUS, United States of America. <sup>2</sup>Center for Biostatistics at The Ohio State University, COLUMBUS, United States of America

## Congestive Heart Failure - HCM

### **Asymptomatic cats with left ventricular hypertrophy AND left atrial dilation (Class B2)**

- Add antiplatelet therapy (Aspirin and/or Clopidogrel) ?
- FATCAT

### **HCM in CHF (class C1)**

- Acute CHF: " FONS"
- Oxygen
- Sedation (butorphanol or acepromazine)
- Furosemide (1-4 mg/kg IV, IM)
- Nitroglycerin ointment ?



## Congestive Heart Failure - HCM

### **HCM in CHF (class C1)**

- Thoracocentesis (if breathing pattern suggests pleural effusion)
- Dobutamine ?
- Pimobendan (0.25 mg/kg PO, BID)

### **HCM in CHF (class C2)**

- Past or present CHF
- 2003: Fox et al (ACVIM 2003): 118 cats. Endpoint death or ATE.

PROSPECTIVE, DOUBLE-BLINDED, MULTICENTER EVALUATION OF CHRONIC THERAPIES FOR FELINE DIASTOLIC HEART FAILURE: INTERIM ANALYSIS. Fox PR<sup>1</sup>. The Multi-center Feline Chronic Heart Failure Study Group. <sup>1</sup>The Animal Medical Center, New York, NY.

- Furosemide alone: 254 days
- Furosemide + ACE-inhibitor: 92 days, hazard ratio 202%
- Furosemide + diltiazem: 153 days, hazard ratio: 124%
- Furosemide + atenolol: 99 days, hazard ratio: 144%



## Congestive Heart Failure - HCM

### **HCM in CHF (class C2)**

- Past or present CHF
- Furosemide: 1-2 mg/kg x PO, SID-BID.
- ATE prevention.
- ACE inhibitors?
- Atenolol?
- Diltiazem?
- Spironolactone ?
- Pimobendan ?



## Congestive Heart Failure - HCM

### **HCM refractory CHF (D - end-stage)**

- Furosemide
- Hydrochlorothiazide
- discuss quality of life

