To BEnazepril or not to BEnazepril, the question of what cardiac drugs to prescribe

Kristy Williams, DVM (Cardiology Residency Trained)

Cardiologist
Cape Cod Vet Specialists

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SPECIALISTS

Who am I?

- Originally from Massachusetts
- Colorado State University
  - Veterinary school 2018-2022
- NC State University
  - Rotating SA internship 2022
  - Cardiology residency 2023-2026
- CCVS Cardiology, Buzzards Bay
  - Started September 2026
- Special interests:
  - Valvular heart disease and chronic management
  - Feline cardiomyopathy
  - Heartworm
  - Teaching!



COLLEGE OF VETERINARY MEDICINE AND BIOMEDICAL SCIENCES
COLORADO STATE UNIVERSITY

NC STATE UNIVERSITY College of Veterinary Medicine

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Outline

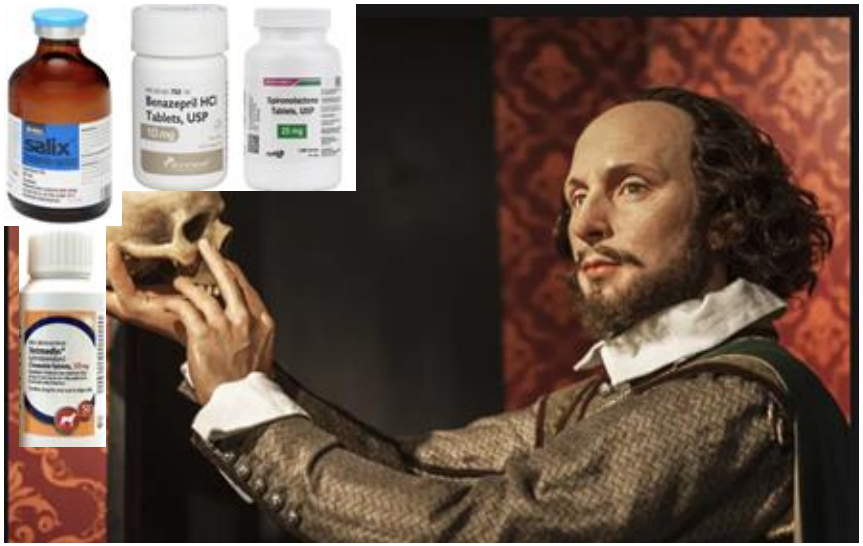
Heart disease overview

Heart failure

Common medications

Other/ new medications

Anesthesia



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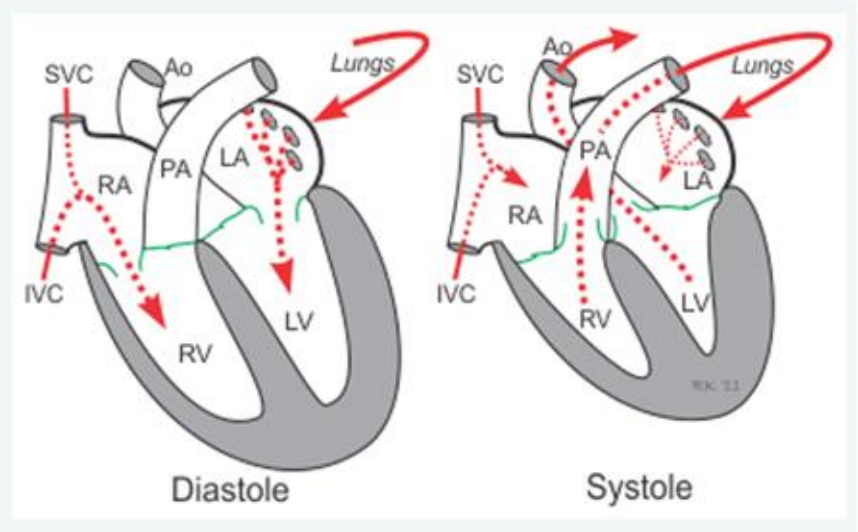
Heart Disease

The heart is a pump!

(please don't throw anything at me)



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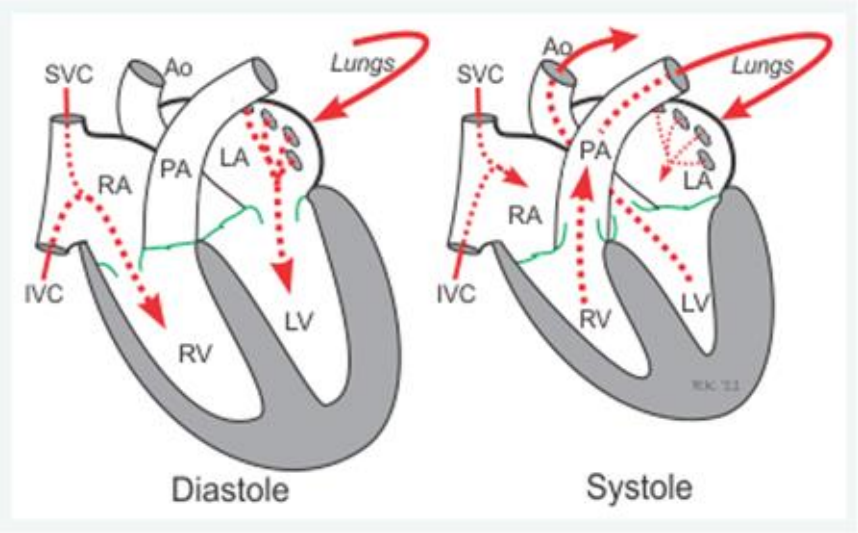
Heart Disease

The heart is a pump!

And blood is dumb.



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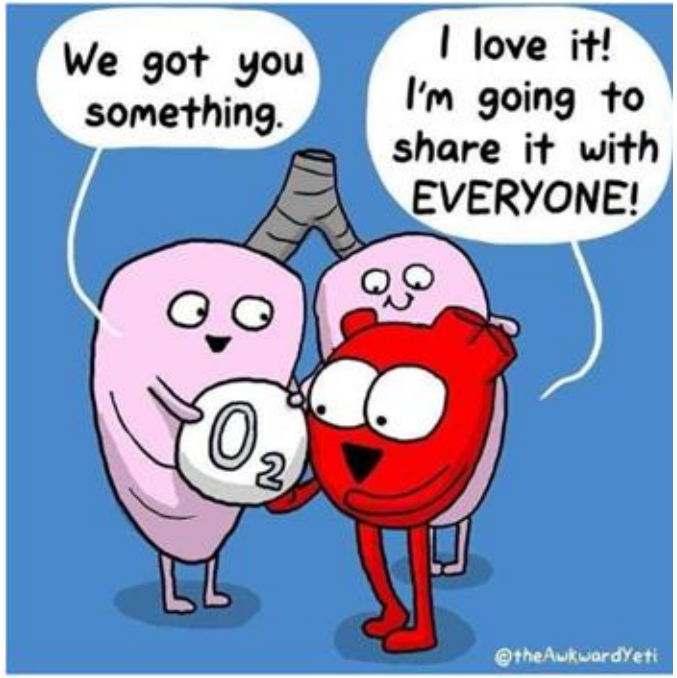
Heart Disease

The heart is a pump!



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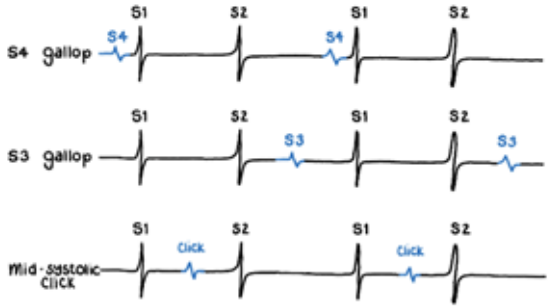
Diagnosing Heart Disease

- Physical exam! MM, pulses, auscultation, jugular venous/abdominal distension
- Stethoscope
  - Diaphragm (firm pressure): attenuates low frequency sounds (murmurs)
  - Bell (light pressure): transmits low and high frequency sounds (heart sounds)

*Gallop is a SOUND not a rhythm



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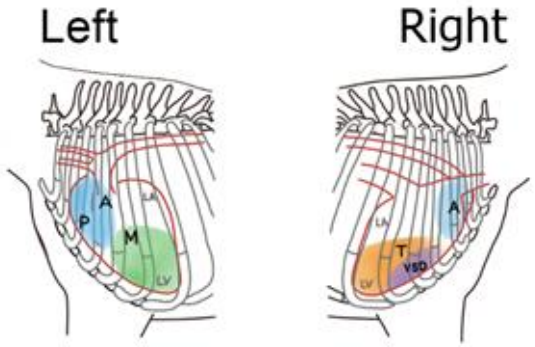
Diagnosing Heart Disease

- Describing
  - Systolic (>95% of murmurs): DMVD, DCM, PS, SAS, VSD, HCM
  - Holosystolic: lasting entire systole, but still hear discrete S1/S2
  - Pansystolic: lasting entire systole, obliterating S2
  - Diastolic (RARE): AR, PR
  - Continuous: PDA
- Location- PMI
- Intensity- Grade I-VI



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Diagnosing Heart Disease

- Intensity
  - Grade I = very faint, very focal, quiet room; may be intermittent
  - Grade II = soft, focal over only 1 valve area, but heard consistently
  - Grade III = moderate, radiates to multiple valve areas on one hemithorax
  - Grade IV = loud, radiates to both sides of chest
  - Grade V = palpable precordial thrill (“bag of buzzing bees”)
  - Grade VI = palpable precordial thrill, audible with stethoscope held 1cm off chest

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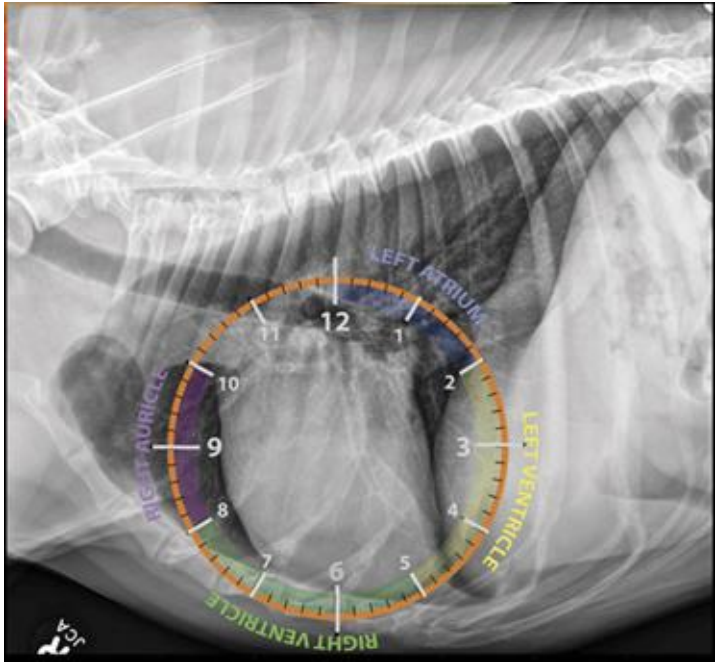
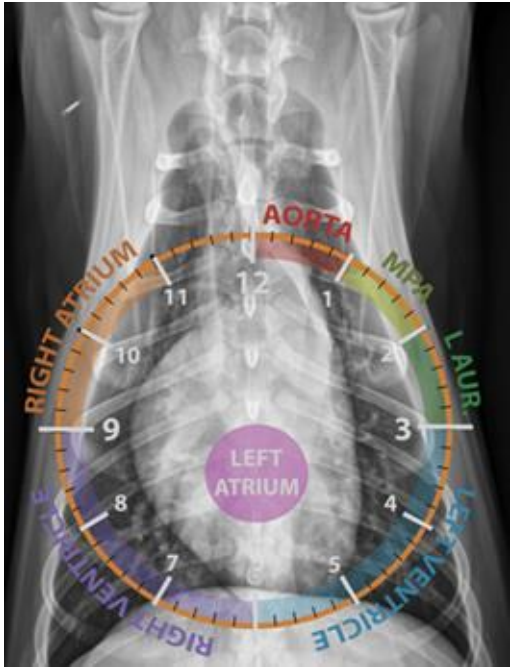
Diagnosing Heart Disease

- Thoracic radiographs: VHS, VLAS
- https://cardiaceducationgroup.org/wp-content/uploads/2024/09/CEG-Practice-Pointers-VHS-and-VLAS.pdf





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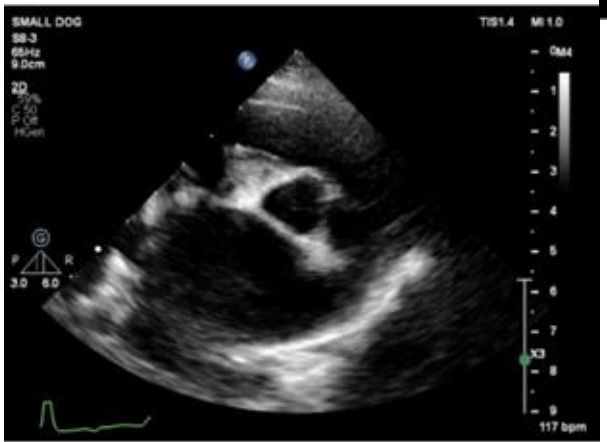
Diagnosing Heart Disease

- Physical exam, blood pressure
- Thoracic radiographs
- Biomarkers: NT-proBNP/Troponin
- POCUS (emergencies)
- Echocardiogram





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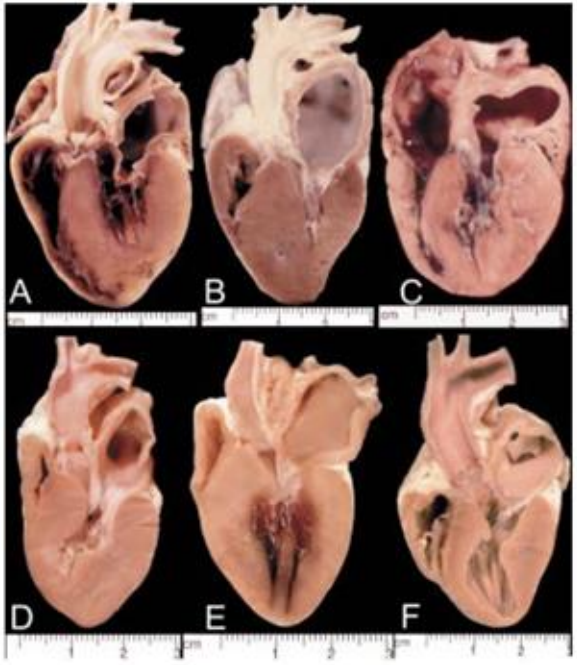
Feline Heart Disease

Focusing on acquired today

Congenital

Acquired

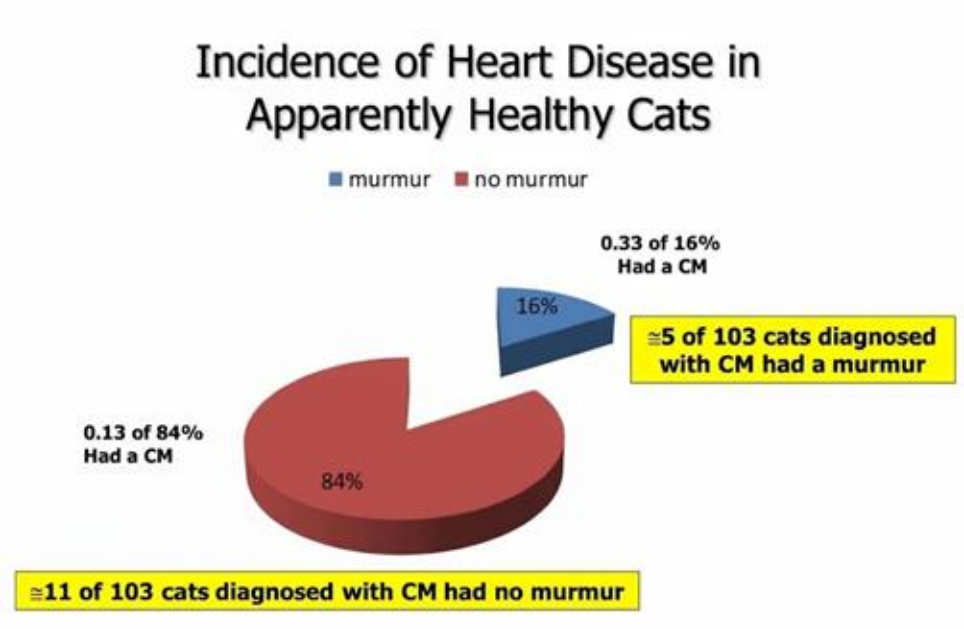
- Hypertrophic cardiomyopathy
- Restrictive cardiomyopathy/unclassified
- Transient myocardial thickening (TMT)
- DCM
- Arrhythmias



Fox. JVC 2003

Feline Heart Disease

Difficult to diagnose



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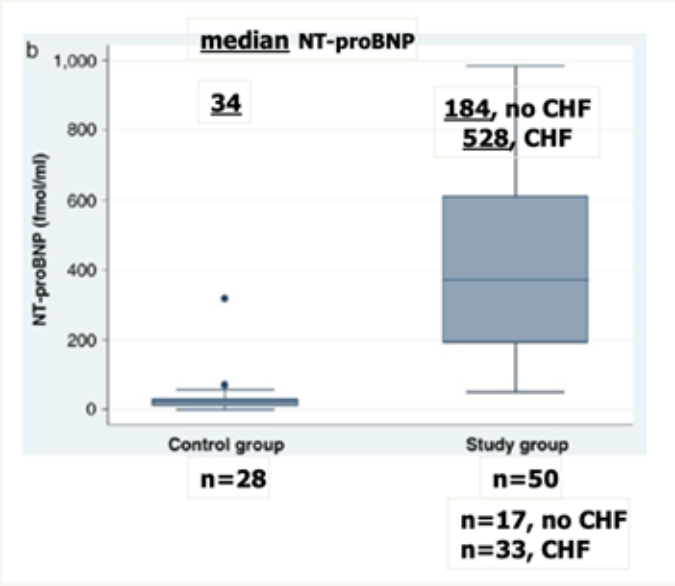
Feline Heart Disease

NT-proBNP, T4, Blood pressure, CXR, POCUS



Connolly DJ, et al. Circulating natriuretic peptides concentrations in cats with respiratory distress.
J Vet Intern Med. 2008;22:95–105.

Respiratory vs. cardiac disease

- NTproBNP >220 pmol/L
- Sensitivity: 94%
- Specificity: 88%

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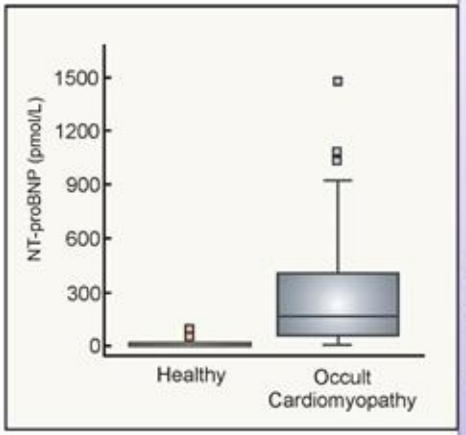
Feline Heart Disease



114 normal cats: 113 cats with occult CM

Multicenter, blinded prospective study

Fox PR, et al. Assessment of NTproBNP concentration in asymptomatic cats with cardiomyopathy *J Vet Intern Med.* 2011

With a cutoff value >46 pmol/L

Sensitivity = 91%

Specificity = 86%

for detecting occult cardiomyopathy.

When the NTproBNP was >99pmol/L ,
all cats had heart disease or 100% specificity

NTproBNP positively correlated with:

Dynamic LVOT obstuction, LV Posterior Wall thickening

Left atrial:aortic ratio

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Feline Heart Disease

Issues with proBNP

- Species specific assay
- Proper sample handling very important
- Turn around time
- Week to week variation in normal dogs
- Magnitude of elevation varies with type of heart disease
- Affected by co-morbid conditions
  - Renal disease
  - Critical illness
  - Severe pulmonary disease and hypertension

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Feline Heart Disease

Recommend imaging prior to medical therapy in asymptomatic patients

- Strongly recommend echocardiogram to determine heart disease



Journal of Veterinary Internal Medicine

ACVIM

CONSENSUS STATEMENT | Open Access

ACVIM consensus statement guidelines for the classification, diagnosis, and management of cardiomyopathies in cats

Virginia Luis Fuentes, Jonathan Abbott, Valérie Chetboul, Etienne Côté, Philip R. Fox, Jens Häggström

... See all authors

First published: 03 April 2020 | https://doi.org/10.1111/jvim.15745 | Citations: 43

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Canine Heart Disease

Focusing on acquired today

Congenital

Acquired

- Valve disease (DMVD)
- DCM
- Pulmonary hypertension*– RCHF
- Infective endocarditis – uncommon
- Arrhythmias – usually “additive” but can be primary cause

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Canine Heart Disease

Valve disease

- Highly prevalent >85% small breed dogs by 13 years
- **Slowly** progressive in asymptomatic small breed dogs ->~70% (n = 558) still alive after 6 years
- Many (most) dogs do not require therapy
- Large breeds also get MMVD
  - Faster progression, overt myocardial dysfunction, afib

J Vet Intern Med. 2019 May;33(3):1127-1140. doi: 10.1111/jvim.15488. Epub 2019 Apr 11.

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

Keene BW[1], Atkins CE[1], Bonagura JD[1,2], Fox PR[3], Häggström J[4], Fuentes VL[5], Oyama MA[6], Rush JE[7], Stepien R[8], Uechi M[9].

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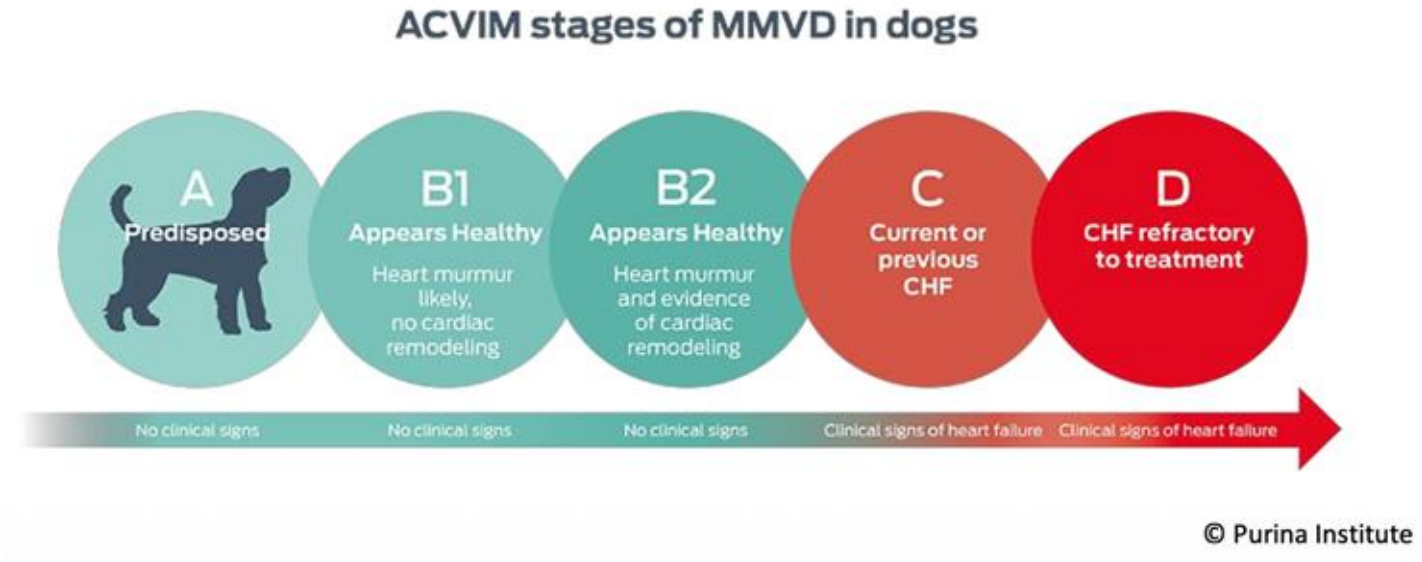
Canine Heart Disease

Valve Disease



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Canine Heart Disease

B2/EPIC criteria

- If all of the following:
- **Loud ≥3/6 left apical systolic murmur**
- Echo: LA:Ao ≥1.6, LVIDdN ≥1.7 (cm/kg0.294), breed-adjusted" VHS >10.5
- If echo declined- Thoracic radiographs with evidence of left heart
- enlargement AND…
- **VHS ≥ 11.5 +/- VLAS ≥ 3.0**
- Could start pimobendan 0.25-0.3 mg/kg PO q12 +/- ACE inhibitor
- VHS Velocity=Current VHS−Previous VHS/Months between exams

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Canine Heart Disease

Medications



- None

- None

- Pimobendan
- +/- ACEi

- Pimobendan
- ACEi
- Furosemide
- Spironolactone

- Torsemide
- Hydrochlorothiazide
- Acetazolamide
- Amlodipine

Pimobendan

Indications

- Congestive heart failure from DCM or DMVD (approved)- shown to improve outcome
- Advanced heart disease before CHF (EPIC study)-**B2, shown to delay CHF**
- Cats?

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Pimobendan

MOA

Calcium sensitizer

Increases interaction between Ca and Troponin C

→ increased actin-myosin cross-binding

→ greater force of contraction (positive inotrope)

PDE3 inhibitor

→ increases cAMP mediated peripheral vasodilation

Inotrope + vasodilation = “inodilator”



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Pimobendan

Side effects
Uncommon
Excitability, GI upset, arrhythmia?

Dosage
0.25mg-0.3 mg/kg q12hr

IV dose is less: 0.15 mg/kg IV- hard to obtain :(

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Pimobendan

In cats?

- No pimobendan formulations have been approved for use in cats.
- 1.25 mg PO q12h has become the most clinically utilized dosage
- **Recommend echocardiogram prior to starting pimobendan**
- Acute setting?
- Pimobendan use is not recommended in cats with fixed obstructions of the left or right ventricular outflow tract (ie, aortic or pulmonic stenosis or fixed midventricular obstructions).

doi:10.1177/1098612X251386638 Gordon SG 2025

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Pimobendan

Table 3 Recommendations for pimobendan use in cats with heart disease NOT confirmed and characterized by echocardiography

	Pimobendan indication		
	Stage B2: subclinical with substantial LA dilation in most cases	**Stage C: current or historical left-sided CHF**	**Stage D: left-sided CHF refractory to standard therapy**
Presumed diagnosis of cardiomyopathy – with NO evidence of poor perfusion	Never indicated in subclinical disease without an echocardiographic diagnosis	Not indicated in cats easily stabilized on empirical CHF therapy (case scenario 2)	Recommended as rescue therapy with owner approval*
Presumed diagnosis of cardiomyopathy – with evidence of poor perfusion	Never indicated in subclinical disease without an echocardiographic diagnosis	Consider*	Recommended as rescue therapy with owner approval*

Note: For some diagnoses, peer-reviewed clinical data are limited or absent; some recommendations are therefore based on anecdotal reports and the authors' experience
*Consultation with a cardiologist could be beneficial
CHF = congestive heart failure; LA = left atrial

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Heart Failure

THE USUAL SUSPECTS



DEGENERATIVE MITRAL VALVE DISEASE

- Middle age/older
- Small breed dogs
- Loud, left apical systolic murmur



DILATED CARDIOMYOPATHY

- Middle age
- Large breed dogs (Dobermans, Danes, Boxers)
- +/- Soft left apical systolic murmur
- HIGH PULSE DIET



HYPERTROPHIC CARDIOMYOPATHY

- Middle age
- Male > Female
- DSH, Maine Coon, Ragdoll, Sphynx, other "exotic breeds"
- +/- murmur, +/- S4 gallop

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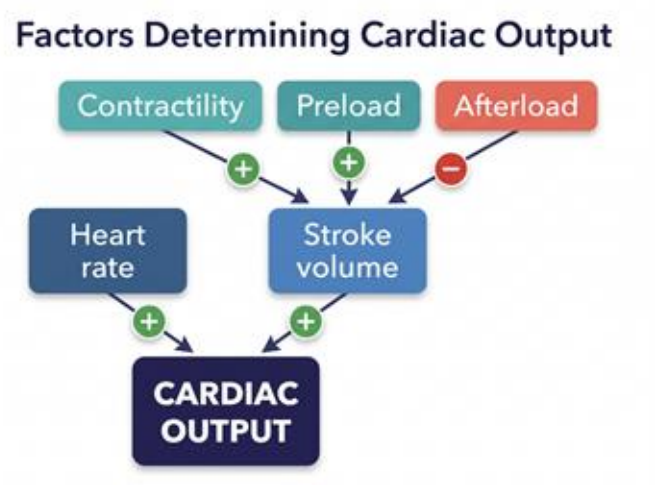
Heart Failure

Pathologic state and clinical syndrome

- Heart is impaired in its ability to eject or receive blood
- Cardiac output does not meet perfusion needs of metabolizing tissues



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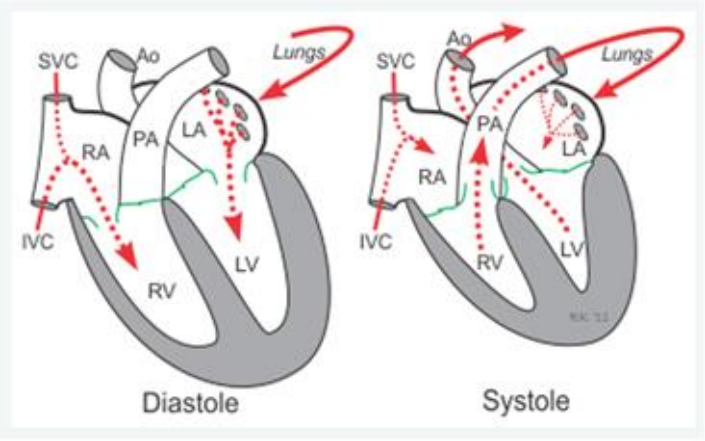
Heart Failure

‘Forward’ heart failure

- Hemodynamic effects, hypotension, increased CRT, collapse/syncope

‘Backward’ or congestive heart failure (CHF)

– Elevated venous pressures lead to passive congestion of organs and fluid accumulations (edema, effusion)



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Heart Failure

Dogs

Left CHF

- Pulmonary edema
  - B-lines**

Right CHF

- Ascites
- +/- Pleural effusion
- +/- Pericardial effusion

Cats

Left CHF

- Pulmonary edema
  - B lines
- Pericardial effusion
- Pleural effusion

Right CHF

(uncommon)

- Ascites
- Pleural effusion
- Pericardial effusion

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Heart Failure

PE findings

Temperature: normal to low
Heart rate: tachycardic
 >140 bpm for dog | >200 bpm for cat OR relative bradycardia
Arrhythmias (SVPCs, VPCs, Afib)
Gallop sound (S4 HCM, S3 DCM)
Respiratory Rate: >40 brpm with effort
Mucus membranes: pink to muddy/cyanotic
Heart murmur (LOUD for MVDD, soft for DCM, +/- for HCM)
Pulmonary crackles (usually soft/fine)
Cachexia/weight loss (especially with R-CHF)

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Diagnosing Heart Failure

T-POCUS	• B lines, increased LA:Ao, pericardial effusion, pleural effusion
A-POCUS	• Effusion, distended caudal vena cava
CXR	• Enlarged left heart (tall with LA bump), VHS > 11.5, dilated pulmonary veins, interstitial to alveolar pattern (caudodorsal or perihilar)
BNP	• Cage-side SNAP proBNP for CATS (low stress, fast)

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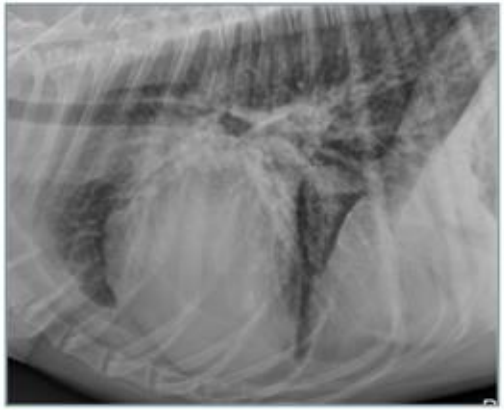
Diagnosing Heart Failure

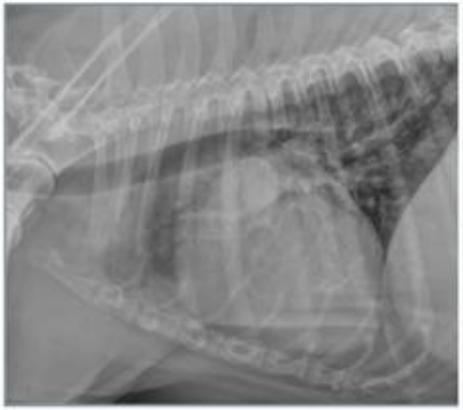
THORACIC RADIOGRAPHS: DOG



MVDD
Classic caudodorsal pattern, can be asymmetric



DCM
mainly perihilar/caudodorsal, sometimes wide distribution



Pulmonary Hypertension
Enlarged R heart, dilated PA, +/- infiltrates

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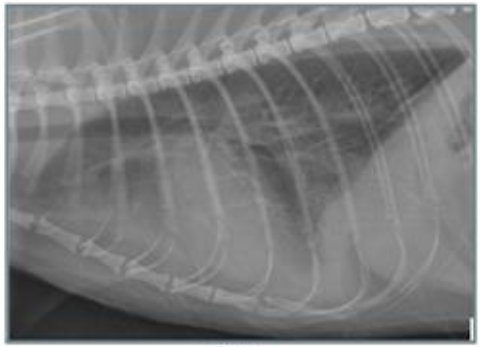
Diagnosing Heart Failure

THORACIC RADIOGRAPHS: CATS

Normal Cat





CHF



CHF

Feline HCM



BOTTOM LINE: Cats are HARD; can have a normal heart on rads, enlarged pulmonary arteries + veins, and can put edema wherever they want… use your T-POCUS/SNAP proBNP

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Heart Failure

Acute CHF

DOG

FOPS
Furosemide
Oxygen
Pimobendan
Sedation
Nitroglycerin
Dobutamine
Nitroprusside

CAT

Furosemide
Oxygen
+/- Pimobendan
Sedation
+/- Thoracocentesis
Clopidogrel
Nitroglycerine
Dobutamine
Nitroprusside

Inpatient-to-Outpatient CHF

DOG

Dogs Are For Special People
Dietary Na+ restriction
ACEi
Furosemide
Spironolactone
Pimobendan
Amlodipine
Diltiazem/Digoxin: if A-fib

CAT

Don't Forget About Cats, Please
Dietary Na+ restriction
Furosemide
ACEi
Clopidogrel
+/- Pimobendan

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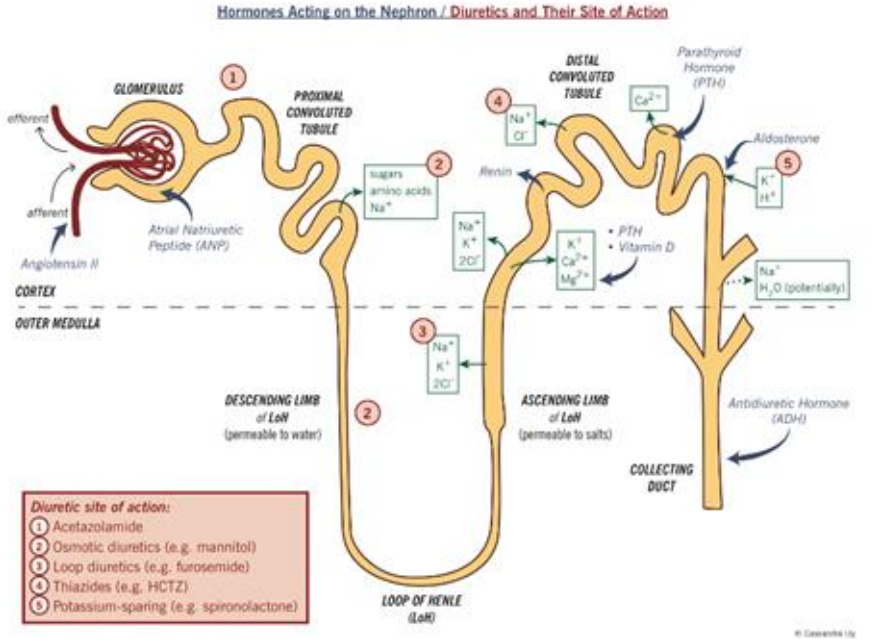
Diuretics

The topic is a little dry…



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Diuretics

The topic is a little dry



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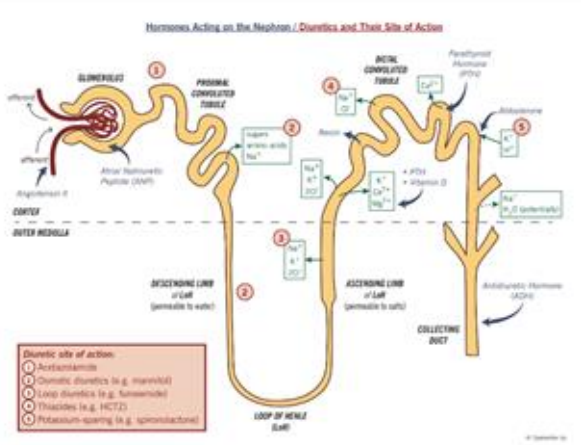
Diuretics

The topic is a little dry…

- Carbonic anhydrase inhibitors (CAIs)- Acetazolamide
- Osmotic diuretics
- **Loop diuretics-Furosemide/Torsemide**
- **Potassium-sparing diuretics- Spironolactone**
- **Thiazide- Hydrochlorothiazide**



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Loop Diuretics

Indications

Congestive heart failure (CHF)

Left sided CHF- pulmonary edema

Right sided CHF- effusions

Acute emergency setting

Chronic daily use

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Loop Diuretics

MOA

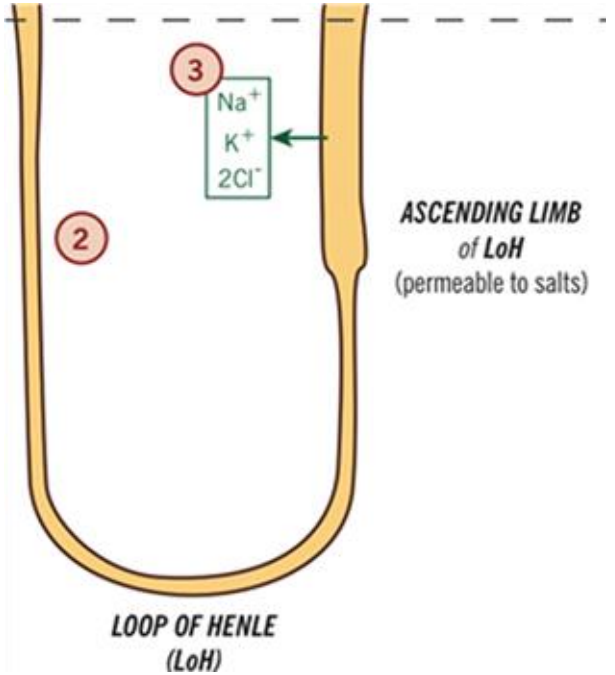
- Inhibits Na/K/2Cl cotransporter in thick ascending limb Loop of Henle

→ Na, K, Cl reabsorption is decreased

→ Water follows those ions

→ out in urine instead of getting reabsorbed

= diuresis



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Loop Diuretics

Furosemide

- Less potent
- Shorter duration of action
- Very high initial excretion rate->decreases rapidly in dogs

Torsemide

- More potent
- Longer duration of action
- Increases plasma aldosterone
- Higher PO availability

Typically used as second line after max furosemide doses are reached. **In hospital- still give IV furosemide**

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Loop Diuretics

Side effects

Excessive dosage (common)

→ azotemia, weakness, dehydration, lethargy, electrolyte depletion (Hypo Na^+, **Cl^-,** K^+, Mg^+), and hypotension

GI upset, pancreatitis

Rapid IV → deafness

Increased thirst and urination (**must allow free access to H2O)**

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Loop Diuretics

- Large range for dosing and can depend on clinician and case

Furosemide:

- Acute HF: Typical starting dose of 2 mg/kg IV q6-12hr PRN
- CRI: 0.66mg/kg/hr after initial bolus (often wean to 0.33mg/kg/hr as RR/RE ↓)
- Chronic HF: Typically 1-2 mg/kg q8-12 PO TGH (case depending)
- Cats typically are 1 mg/kg to start depending on severity.
- Should tap to remove effusions rather than relying on high dose diuretics

Torsemide is typically 1/10 to 1/20 dose of furosemide TGH

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Diuretic Resistance- not futile

- If no resistance- rapid hypovolemia would ensue
- Considered to be decreased sensitivity to diuretics-> resulting natriuresis and diuresis are insufficient to alleviate congestion or achieve euvolemia.
- Dogs with chronic CHF- resistance based on the administered dosage relative to clinical signs, and defined as the need for >8 mg furosemide/kg/d to control clinical signs of congestion.

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Spironolactone

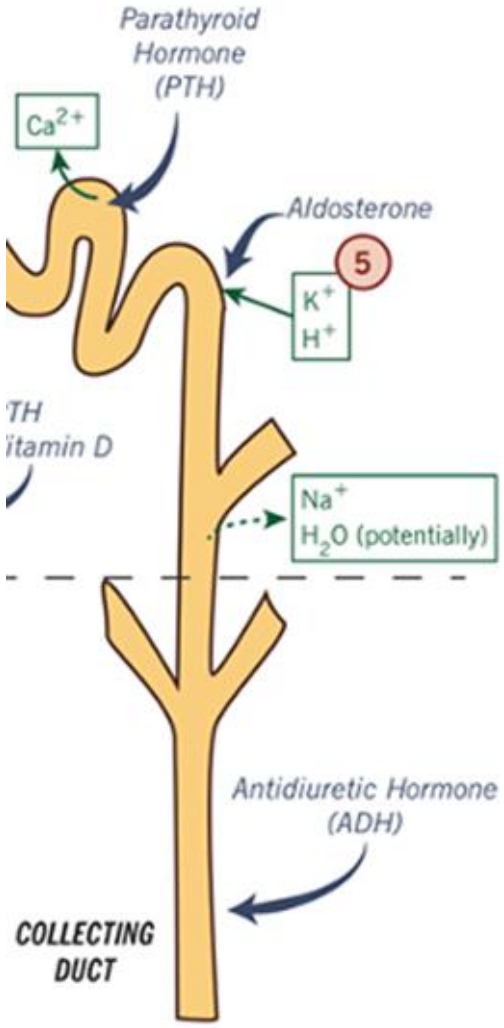
MOA

- Aldosterone antagonist
- Aldosterone causes Na and H2O retention

(and K excretion) in distal tubule and collecting duct

→ weak diuretic effect

- K “sparing” diuretic



Spironolactone

Indications

- Refractory CHF
- Usually in addition to furosemide
- Quadruple therapy for valve disease CHF

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Spironolactone

Side effects

- Side effects
- GI upset (vomiting, anorexia)
- Hyperkalemia
- Azotemia
- Facial excoriations/itching in cats

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Diuretics

“Braking effect”

- Decreased diuretic effect due to RAAS activation

“Diuretic tolerance”

- Increased Na absorption due to hypertrophy of the distal nephron

Add on additional diuretics-Hydrochlorothiazide

– blocks sodium transporter in the distal loop

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ACE Inhibitors

Indications

- CHF, +/- preventing cardiac remodeling before CHF
- Protein losing nephropathy (PLN) (ARBs)
- Systemic hypertension
- Suppression of RAAS is a key strategy in the treatment of chronic heart disease and thus ACE inhibitors are often utilized (as well as Agll type-1 receptor blockers-ARB and mineralocorticoid receptor antagonists)

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ACE INHIBITORS

TABLE 1 Aldosterone and angiotensin II: harmful cardiovascular and renal effects

Adverse effect	Direct effects of angiotensin II	Direct effects of aldosterone
Myocardial remodeling: fibrosis, hypertrophy, necrosis, apoptosis	Yes	Yes
Vascular remodeling: hypertrophy, fibrosis	Yes	Yes
Increase ROS	Yes	Yes
Pro-inflammatory (cytokines, ROS)	Yes	Yes
Arrhythmogenic	Yes	Yes
Vascular endothelial dysfunction (ET-1, vasopressin, acetylcholine-mediated vasodilatory dysfunctin)	Yes	Yes
Systemic hypertension	Yes	Yes
Glomerular damage	Yes	Yes
Glomerular dysfunction: proteinuria	Yes	Yes
Increased intraglomerular pressure	+++ (vasoconstriction)	+ (fluid retention & SNS)
Tubulointerstitial injury	Yes	Yes
Baroreceptor dysfunction→HR increase	Maybe	Yes
Increased SNS tone	Yes	Yes
Inotropy	Yes	No
Direct HR increase	Yes	No
Salt appetite	Yes	Yes
Increased thirst	Yes	No
Na^+ and H_2O retention, congestion	Yes	Yes
K^+ wasting	No	Yes

Abbreviations: ET-1, endothelin 1; HR, heart rate; SNS, sympathetic nervous system activation; ROS, reactive oxygen species.



https://doi.org/10.1111/jvim.15454

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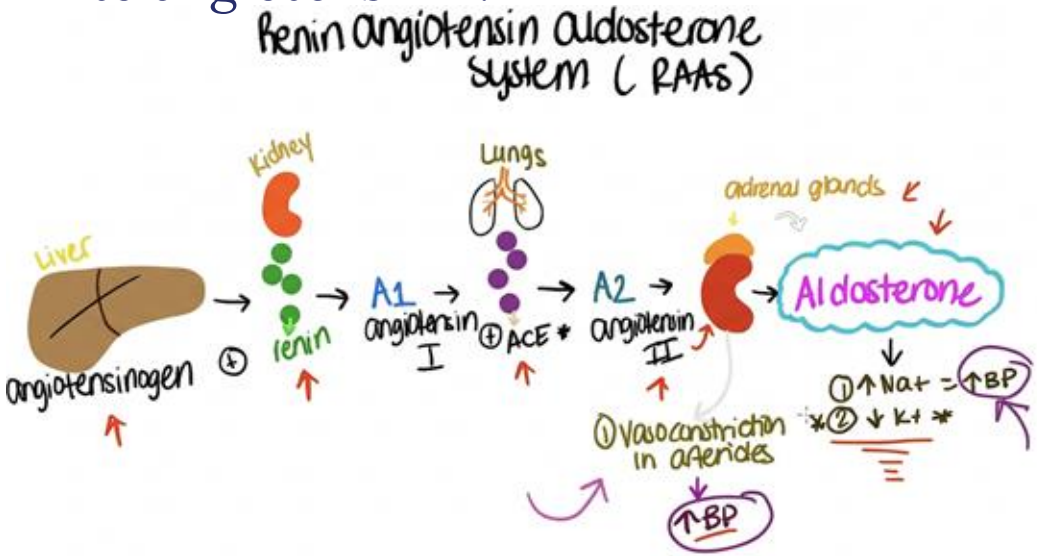
ACE Inhibitors

ACEi mitigate the renin-angiotensin-aldosterone system (RAAS) by inhibiting the action of ACE, the enzyme that catalyzes the conversion of angiotensin I into angiotensin II.



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ACE Inhibitors

MOA

- Inhibits angiotensin converting enzyme (ACE)

→ Inhibits the production of angiotensin II (from AT I)

→ Decreased aldosterone secretion

⇒ ACEi decreases AT II mediated vasoconstriction and aldosterone mediated Na and H2O retention

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ACE Inhibitors
Enalapril or Benazepril?

- Both are prodrugs that must be converted by the liver into their active forms (enalaprilat and benazeprilat)

- Benazepril
  - Roughly 55% via the liver and 45% via the kidneys
  - Can be given q12-24

- Enalapril
  - Primarily excreted through kidneys ~95%
  - Q 12 dosing

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ACE Inhibitors

Ok- do I start them or not?

- Recommend for RAAS inhibition in CHF
- 50% split in consensus statement for B2
- Kidney values, blood pressure, ease of medication with patient
- Inexpensive, typically well tolerated
- Dog PO 0.25- 0.5 mg/kg q12-24hr (withhold or reduce dose if azotemia)
- Cat PO 0.25- 0.5 mg/kg q24hr (withhold or reduce dose if azotemia)
- Telmisartan if proteinuria- angiotensin II receptor blocker (ARB)

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ACE Inhibitors

Side effects

- Hypotension
- Azotemia (concurrent diuretic)
- Renal failure (rare, likely underling dz)
- GI
- Not cough (human)

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New kid on the block

Hey ARNI!



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Entresto

(sacubitril/valsartan)

- Angiotensin receptor neprilysin inhibitors (ARNis)
- Sacubitril- increases vasodilatory peptides leading to greater sodium loss and decreases ventricular hypertrophy and remodeling
- Valsartan - angiotensin II receptor blocker (ARB) that inhibits RAAS



AJVR AVMA

Long-term sacubitril/valsartan is well tolerated in dogs with heart failure and myxomatous mitral valve disease and suggests excellent survival benefits

Justin A. Carlson, VMD, DACVIM[1]*; Joshua A. Stern, DVM, PhD, DACVIM[2]

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[2]Office of Research and Graduate Studies, College of Veterinary Medicine, North Carolina State University, Raleigh, NC

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Entresto

(sacubitril/valsartan)

- 14-30mg/kg PO q12hr – combined mg of sacubitril and valsartan. Avg dose about 20mg/kg PO q12hrs
- Start low. Check renal values/electrolytes and BP
- Tablet sizes: 50 mg (24/26 mg), 100 mg (49/51 mg), 200 mg (97/103 mg) (generic available)

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Rapamycin

Sirolimus

- Macrocyclic lactone- mTOR inhibition
- Inhibits T lymphocyte activation/proliferation
- Reduces abnormal heart muscle cell growth, protein synthesis, and cardiac inflammation.
- The RAPACAT Trial: A multicenter, randomized, placebo-controlled study-low-dose delayed-release rapamycin (0.3 mg/kg once weekly) reduced or halted the progression of maximum left ventricular myocardial wall thickness over 6 months compared to a placebo.

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Rapamycin

Sirolimus

- Felycin-CA1: FDA conditionally approved prescription animal drug containing sirolimus for managing **subclinical** hypertrophic cardiomyopathy (HCM) in cats
- HALT results are pending, B1 and B2
- Side effects uncommon-include liver insult, diabetes, and diabetic crisis. This therapy requires lab work prior to start, at 2 months, 4 months, then every 6 months long term.

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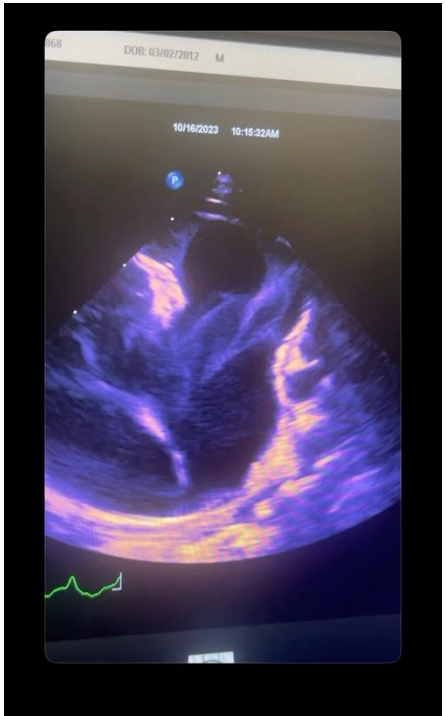
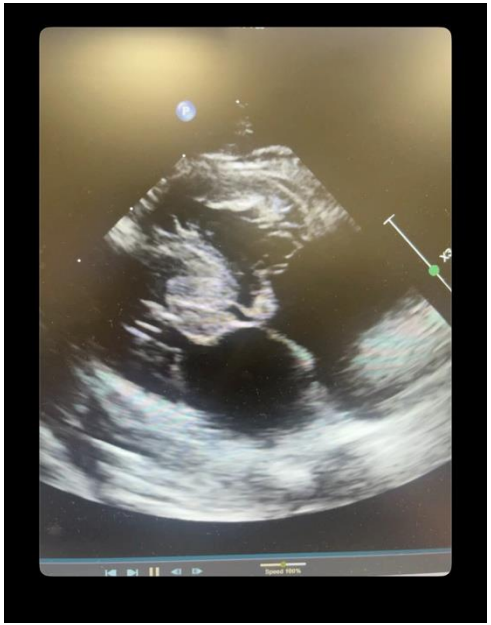
Anti-coagulants

Feline cardiomyopathy- enlarged LA
Sometimes in PH in dogs







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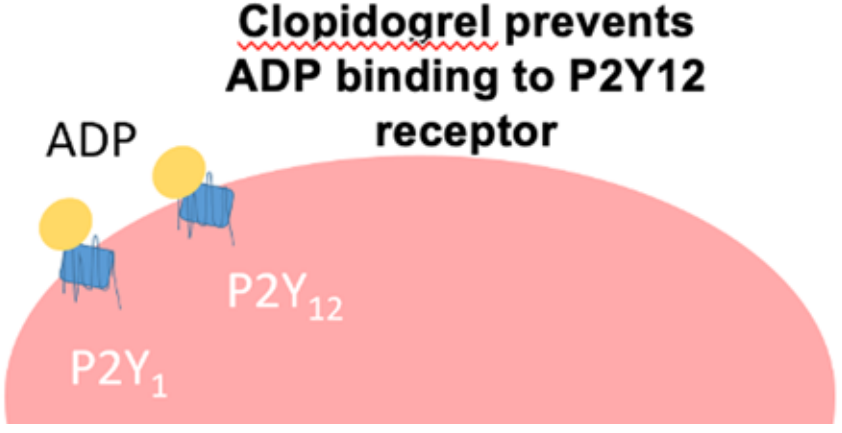
Anti-coagulants

Aspirin, clopidogrel

Arterial clots are platelet rich- recommend platelet inhibition
Options:
Clopidogrel +/- Aspirin (less common after FATCAT Study)



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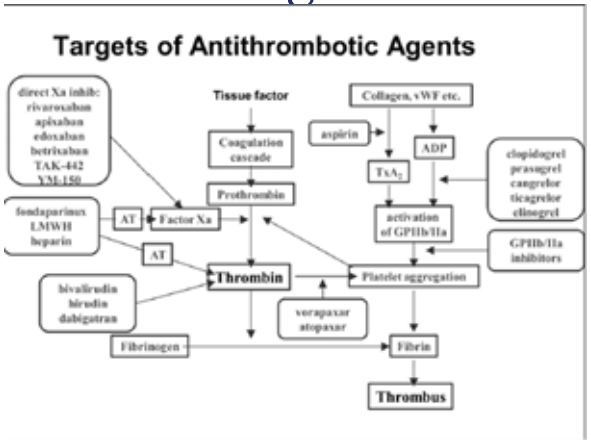
Anti-coagulants

Clotting factor inhibitors

- Low-molecular-weight heparins, namely dalteparin or enoxaparin, target both factor Xa and thrombin

- Oral direct factor-Xa inhibitors (rivaroxaban or apixaban) act by direct inhibition of the activated clotting factor X and prothrombinase activity



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Other therapies

- Afterload reduction
- Positive inotropes
- Beta blockers
- Nutritional

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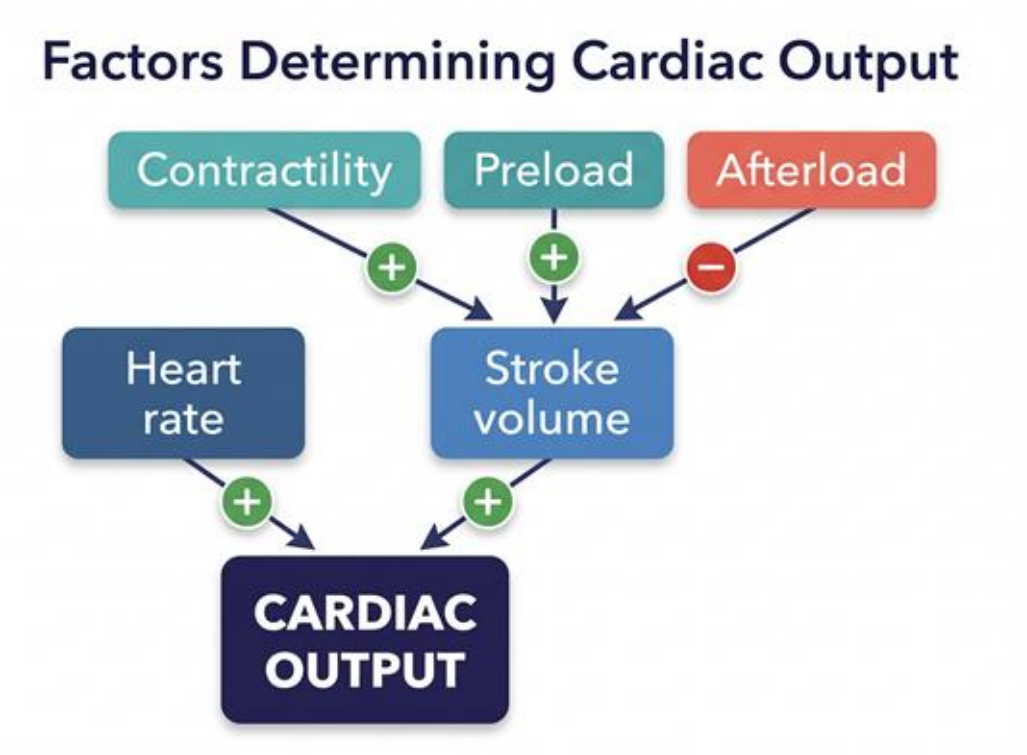
Afterload reduction



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Nitrates

Nitroprusside

Binds oxyhemoglobin to form methemoglobin and release cyanide, NO

Arterial + Venous

Cats risk oxidative injury (Heinz body anemia, etc), use minimal dose

Different line from furosemide CRI

Nitroglycerin

Mitochondrial isoform of aldehyde dehydrogenase (ALDH-2) involved in biotransformation to NO

Venous >> Arterial (good for coronary a)

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Nitrates

- Both drugs: onset and duration = few minutes (IV)
- Transdermal = peak onset 1 h, few hours duration
- Care with sildenafil (PDE V inhibitor)

Side effects:

- Vasodilation
- Hypotension
- Tachycardia
- Cyanide toxicity

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Nitrates

Nitroprusside

- With BP monitoring
- Dog CRI 1-10mcg/kg/min (often start at 2.5mcg/kg/min) with BP monitoring, Plumb's says to dilute to 100 mcg/mL; routinely use 300-500 ug/mL (could go up to 1000ug/mL) to reduce volume
- Cat CRI 0.25-5.0mcg/kg/min

Nitroglycerin

- Nitroglycerine 2%
- 0.25" strip per 5-10kg q8hr for first 24hrs

XT

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Amlodipine

- Class IV – calcium channel blocker
- Use in hypertension, or in normotensive refractory CHF/added afterload reduction
- Dogs: 0.1mg/kg q12-24hr, up titrated to 0.25mg/kg q12-24
- Cats: 0.625mg q24hr, up titrated to 0.625-1.25mg q12-24hr

Compound	Family/Class	Vasodilation	Suppression of cardiac contractility	SA Nodal Suppression	AV Nodal Suppression
Diltiazem	**Benzothiazepine**	**3+**	**2+**	**5+**	**4+**
Verapamil	**Phenylalkylamine**	**4+**	**4+**	**5+**	**5+**
Amlodipine	**Dihydropyridines**	**5+**	**1+**	**1+**	**0**

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Beta Blockers

Atenolol- relatively B1 specific

- Benefit seen in CHF in humans not seen in dogs, not recommended for CHF treatment

CO=SV X HR

- Used in cats with HOCM/LVOT, earlier stages
- Given in congenital heart disease with obstruction- pulmonary valve stenosis, aortic/subaortic stenosis
- Do not recommend giving without echocardiogram

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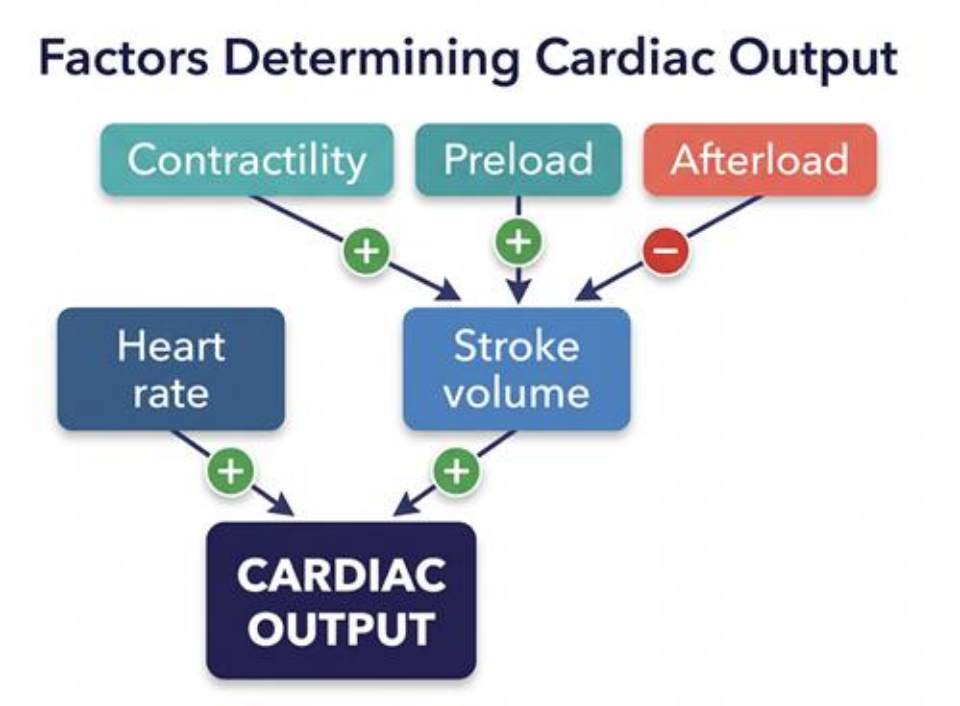
Positive Inotropes



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Positive Inotropes

Dobutamine:
β1-adrenergic agonist (weak β2 and α1)
↑ Inotropy, Lusitropy, Chronotropy
Others: Vasodilation, Bronchodilation, renin release

Dopamine:
Low: D1 receptor agonist (renal vasodilation)
Medium: β1+2-adrenergic agonist (inotropy)
High: α1 agonist (vasoconstriction)
Precursor of norepinephrine/epinephrine

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Positive Inotropes

Digoxin

MOA

Na/K ATPase inhibitor

→ increase in intracellular Na

→ Na/Ca exchanger increases activity to export Na

→ more Ca into cell

→ enhanced myocardial contractility (positive inotrope)

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Digoxin

Positive inotropes

Side effects

Narrow therapeutic window (check dig levels)

GI upset (vomiting, diarrhea, inappetence)

Any arrhythmia

Depression, neuro

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Nutrition

Chloride, supplements and legumes oh my!

- Low sodium diets in refractory CHF
- Limit salty treats
- Hypochloremia has been associated with several poor outcomes – poor diuretic response, higher mortality, and persistent congestion
- Oral KCl study ongoing- Dose 0.5-2 mEq/kg q12hrs, escalated based on electrolytes
- Lower dose if GI side effects when you start
- Relative contraindication is hyperkalemia

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Nutrition

Nutrition-associated Dilated Cardiomyopathy

- Preferred term is high pulse diet, avoiding grain free terminology
  - Pulses are the ingredients that appear to be at the center of the issue – peas, lentils, chickpeas, beans
- Diet history is important (what ingredients, what protein)
- Current thoughts are nutrient deficiency vs toxic factor
  - Deficiency seems less likely
  - Individual variability- genetics/ diet interaction
  - Environmental factors
  - Differences in microbiome-less likely

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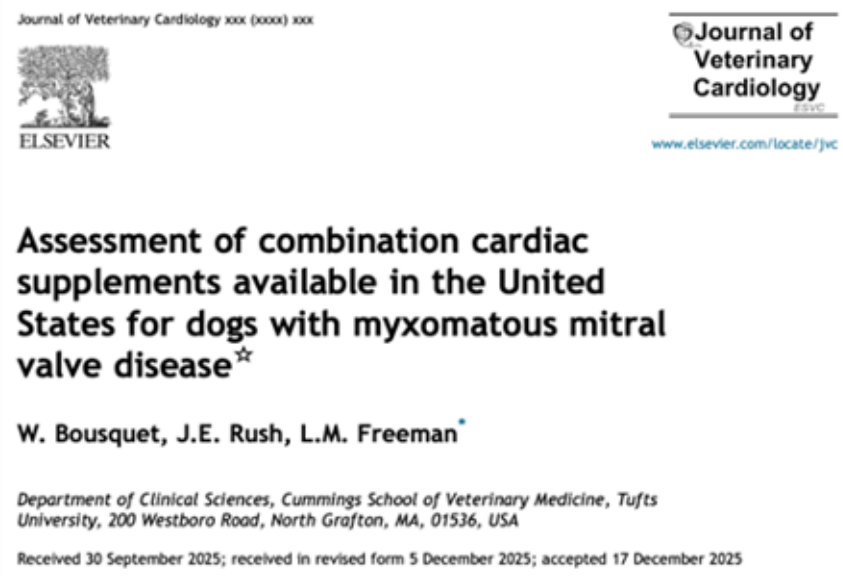
Supplements

Drug approval- multiple steps through FDA
For supplements there are NO requirements



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Assessment of combination cardiac supplements available in the United States for dogs with myxomatous mitral valve disease☆

W. Bousquet, J.E. Rush, L.M. Freeman*

Department of Clinical Sciences, Cummings School of Veterinary Medicine, Tufts University, 200 Westboro Road, North Grafton, MA, 01536, USA

Received 30 September 2025; received in revised form 5 December 2025; accepted 17 December 2025

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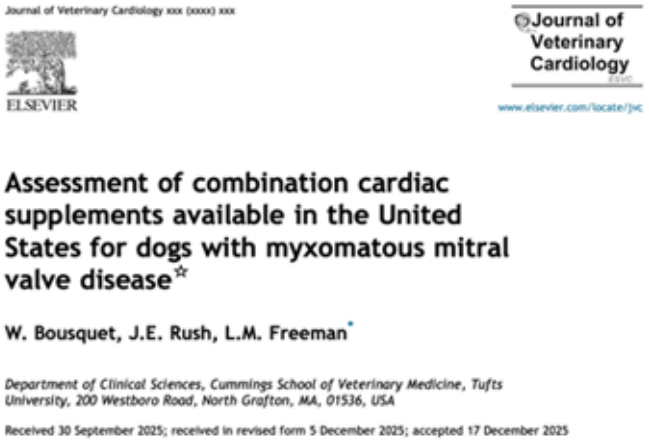
Supplements

147 different active ingredients
63 species plants/herbs
30% spelling mistakes
Only 15% stated potential interactions with cardiac meds
Only 38% products had enough info to calculate dose of active ingredients



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Supplements

Fish oil:

- Omega 3- anti inflammatory effects
- Reduced muscle loss: TNF alpha
- Potential adverse- platelet effects (eicosinoids), GI issues
- Toxicity- Mercury, vitamins A and D or cod liver oil
- 40 mg/kg EPA and 25 mg/kg DHA
- Specific brands- consumerlab.com

Avoid cod liver oil or flax seed oil (not helpful in dogs, useless in cats- can't convert)

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Supplements

Taurine

- Taurine does not play major role in diet associated DCM with high pulse but can have deficiency
- Cats more sensitive, always test taurine in DCM cats
- Cocker spaniels- English/ Sweden uk, golden ret, newfoundlands, homemade diets, low metabolic rate
- Cats- unbalanced diets, vegetarian/ vegan diets
- Test cats with DCM- plasma and whole blood
- 250-1000 mg q12 (Freeman), 500mg q8-12hr (preferably q8hr) or 30-40 mg/kg divided q12hr
- Safe

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Supplements



L carnitine

- Fatty acid metabolism, energy production
- Primary vs secondary deficiency
- Primary boxer deficiency
- 50-100 mg/kg q8-12 or 1-2 grams/dog q8-12hr (preferably q8hr)
- Adverse: GI issues
- TmAO- metabolite from microbiome- Carnitine tartrate tetrahydrate stones
- More cautious for carnitine than taurine

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Supplements

- Is it helpful? Is it hurtful?
- Rec one supplement at a time
- Appropriate dose for individual diet- Omega 3 in their diet too
  - Cardiac care- high in fish oil may not need to supplement
- Use individual not combination supplements
- FDA recalls, national animal supplement council, USP supplement verification program, consumerlab.com

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Anesthesia

Depends on what heart disease and stage!

- Gabapentin/trazodone as premed
- Premedicating with an opioid and midazolam. Induce with propofol and maintain with iso- or sevoflurane.
- Judicious use of IV fluids (2-3 ml/kg/hr)
- Avoid dexmedetomidine and telazol. High dose ketamine in many cases as well.
- Reach out if questions about anesthesia for a case
- Hold ACE inhibitors 48-72 hours prior to procedure

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Fluids

Depends on what heart disease!

Can not answer the question- how much fluid is too much?
Can give overview recommendations but it must be watched and adjusted closely (same as any patient)
Avoid IV fluids in severe heart disease/CHF

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Sildenafil

If not responding- is it CHF?

- Pulmonary hypertension can be difficult to diagnose
- If not responding to high doses of furosemide- might not be the heart
- Oxygen is a great vasodilator! Sedation is your friend.
- MOA PDE5 inhibitor → increased cGMP → increased NO mediated vasodilation
- PDE5 mostly found in pulmonary vasculature and corpus cavernosum

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Take Away

CHF/ Emergency Cases

- Assess for stability for diagnostics
  - Important to have CXR but risk/benefit when unstable
- Does the PE and presentation fit with CHF?
- Ensure you have appropriate monitoring
- The medications only start working once you GIVE them
- Please do not forget the patient care
  - Make water available for patients on furosemide
  - Make sure they have the opportunity to urinate
  - Reduce stress

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Take Away

Outpatient

- Owner discussion/education is important
- Resting/sleeping respiratory rates are VERY HELPFUL- **Cardalis app** for owners
- Avoid prematurely starting life-long cardiac meds
- There are a lot of medical options: offer referral
- Cats are tricky in every possible way
- HW prevention in dogs and cats!
- Most small breed dogs in HF have loud murmurs
- Most dogs in HF have at least moderate cardiomegaly on multiple/orthogonal views
- Call us if you need us!

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QUESTIONS?

Feel free to email any questions to
kristinawilliams@capecodvetspecialists.com

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