Diagnosing Cardiac Disease Without a Cardiologist

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London Vet Show

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Conflict of Interest Disclosure

Employee of the University of Edinburgh

I have received consultancy fees from Idexx

This talk is sponsored by Idexx

Thank you to Allison Spake for providing some of these slides (they have been adapted).

The information contained herein is intended to provide general guidance only. As with any diagnosis or treatment you should use clinical discretion with each patient based on a complete evaluation of the patient, including history, physical exam and presentation, and laboratory data. With respect to any drug therapy or monitoring program, you should refer to a product insert, for complete description of dosage, indications, interactions, and cations, Diagnosis, treatment, and monitoring should be patient specific and is the responsibility of the veterinarian providing primary care.

Agenda

- Overview of most common diagnostic tests

- Overview of most common diseases in dogs and cats
  - Myxomatous mitral valve disease
  - Dilated cardiomyopathy
  - Feline cardiomyopathies

Diagnosing the underlying disease usually requires advanced diagnostics…

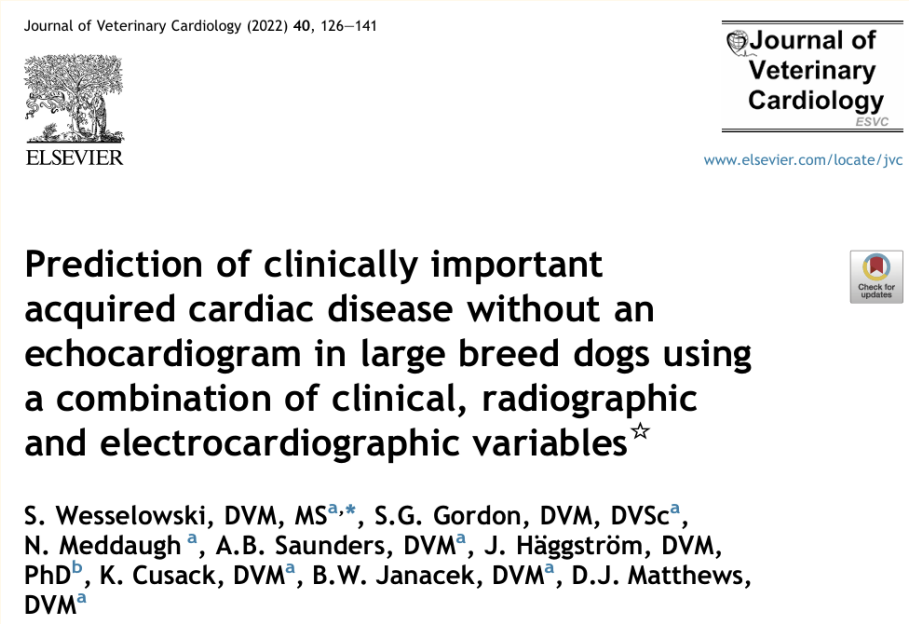
- **Pre-clinical Disease**
  - Screening Tests

- **Clinical Disease**
  - Congestive heart failure
    - Left-sided
    - Right-sided
  - Thromboembolism (cats only)
  - Syncope/exercise intolerance/weakness
  - Polycythaemia

History

Pre-clinical

- Signalment
- Family history



Journal of Veterinary Cardiology (2022) 40, 126–141

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Journal of Veterinary Cardiology
ESVC

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Prediction of clinically important acquired cardiac disease without an echocardiogram in large breed dogs using a combination of clinical, radiographic and electrocardiographic variables☆

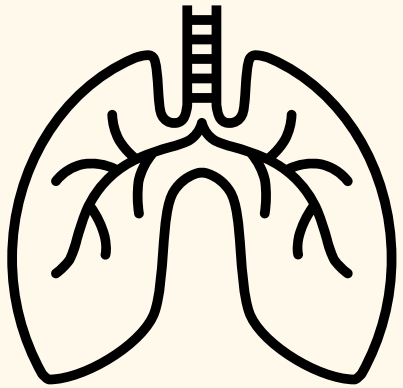
S. Wesselowski, DVM, MS[a,*], S.G. Gordon, DVM, DVSc[a], N. Meddaugh [a], A.B. Saunders, DVM[a], J. Häggström, DVM, PhD[b], K. Cusack, DVM[a], B.W. Janacek, DVM[a], D.J. Matthews, DVM[a]

MMVD still more common than DCM in large breed dogs (>20kg)

Cough

- Left atrial enlargement
- Radiographic airway changes

- Congestive heart failure not statistically associated with coughing in dogs with MMVD.
  - Fulminant pulmonary oedema
  - Pleural effusion



Cough receptors

C-fibres

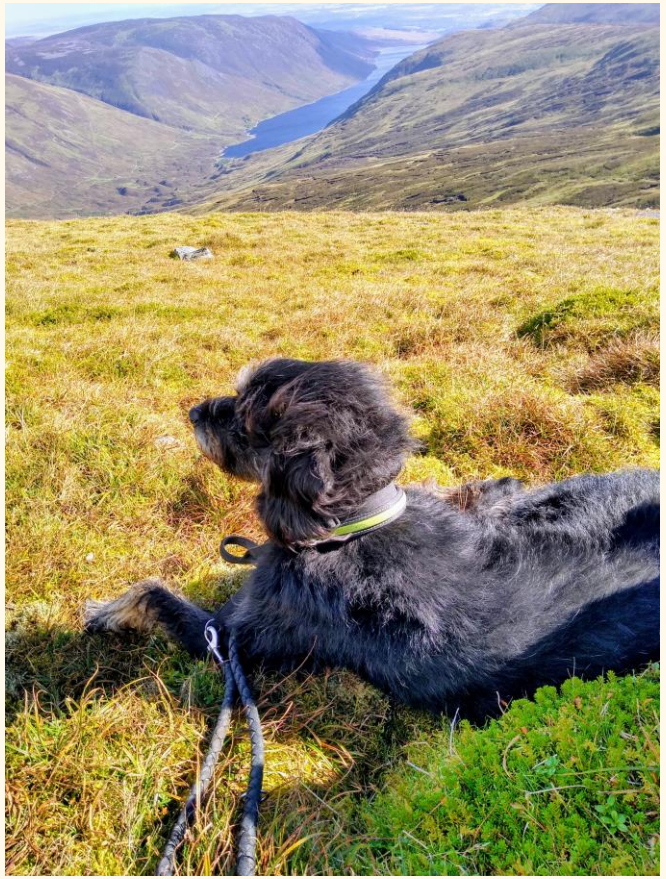
(Ferasin L, Crews L, Biller DS, Lamb KE, Borgarelli M. Risk factors for coughing in dogs with naturally acquired myxomatous mitral valve disease. J Vet Intern Med. 2013 Mar-Apr;27(2):286-92.)

Sleeping Respiratory Rate

- **<30 breaths/minute** in healthy dogs and cats, subclinical heart disease and well controlled CHF
- <40 occasionally
- Sensitive and specific for LCHF in patients with underlying cardiac disease
- Dyspnoea progresses rapidly
- Degree of owner commitment affects survival

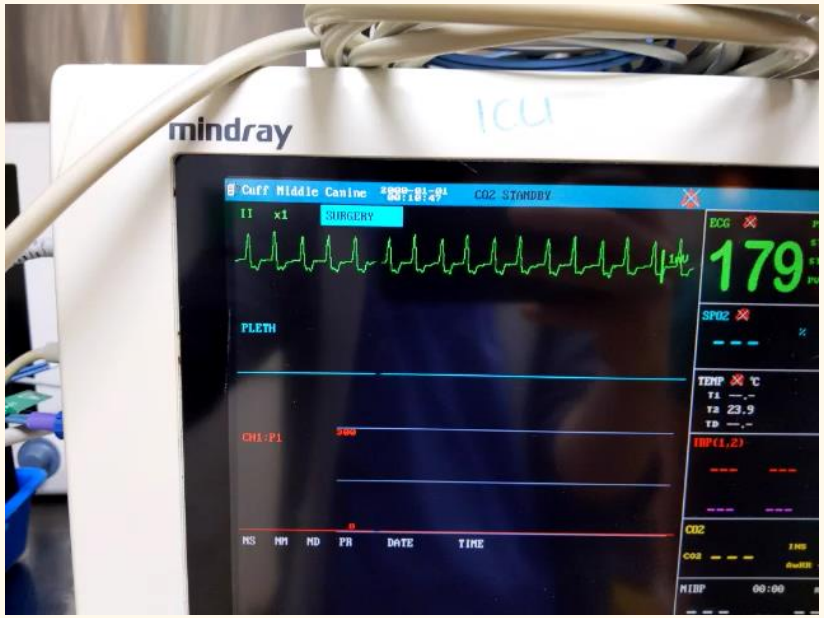
Exercise Intolerance

- Not often an isolated symptom
- Question what “normal” exercise levels are



Syncope

- Transient Loss of Consciousness
- Detailed history



Physical examination

Most dogs with heart disease have a murmur

- Grade of murmur usually correlates with severity of disease

  - **MMVD:**
    - Louder murmur correlates with larger left atrium
    - Louder murmur correlates with increased likelihood of CHF

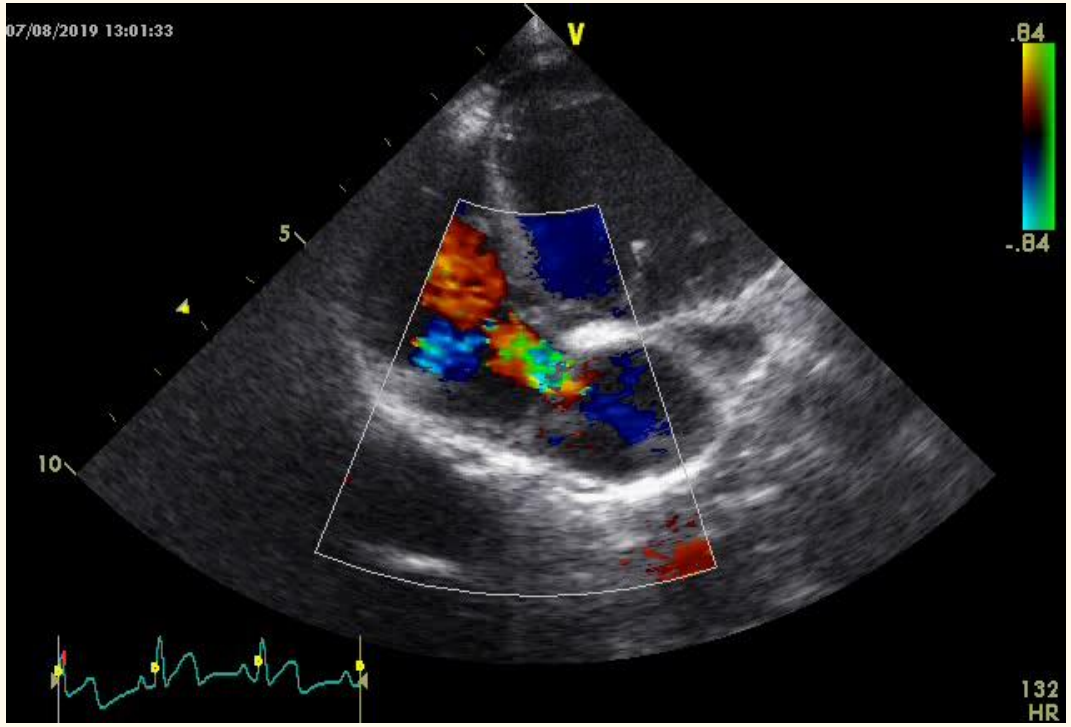
  - **Pulmonic and subaortic stenosis:**
    - Soft murmurs all had mild stenosis
    - Loud murmurs usually had severe stenosis

Ljungvall, I., Rishniw, M., Porciello, F., Ferasin, L. and Ohad, D.G. (2014), Murmur intensity in small-breed dogs with myxomatous mitral valve disease reflects disease severity. J Small Anim Pract, 55: 545-550. https://doi.org/10.1111/jsap.12265

Caivano, D., Dickson, D., Martin, M. and Rishniw, M. (2018), Murmur intensity in adult dogs with pulmonic and subaortic stenosis reflects disease severity. J Small Anim Pract, 59: 161-166. https://doi.org/10.1111/jsap.12760

Cardiac disease can be present with no murmur

- DCM
- Large VSD
- Cor triatriatum dexter
- R-L shunting PDA
- ASD



Not always sensitive

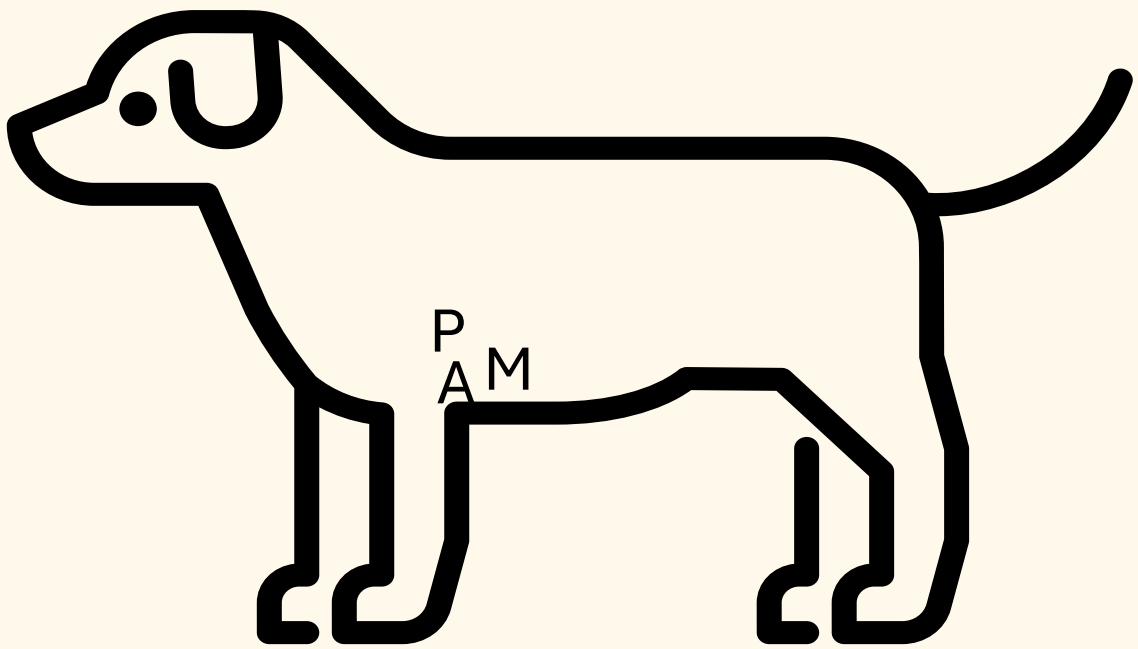
Innocent murmurs can occur in dogs

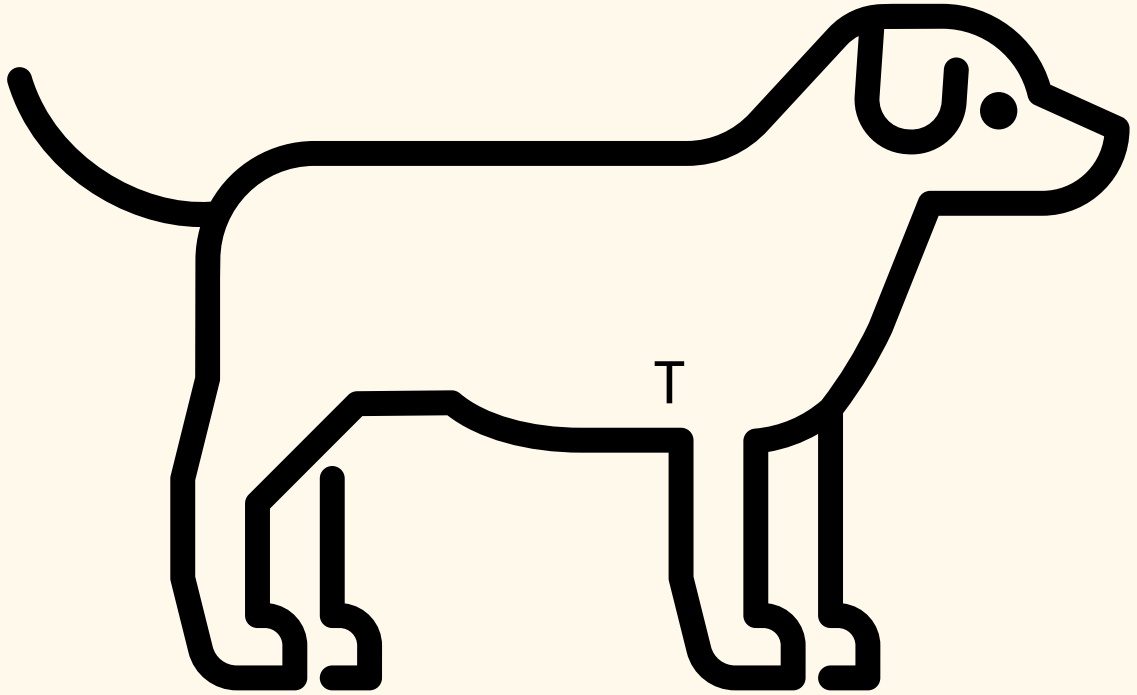
- **“Innocent”/”flow”/”physiologic”/”non-pathological”**
  - 15-28% of puppies
  - 6-12% of young adults, 27-50% were physiologic

Not always specific

- Grade I-II/VI
- Left basal
- Mid-systolic
- No radiation

Point of Maximal Intensity of Heart Murmur





Murmurs are not such a good screening test in cats

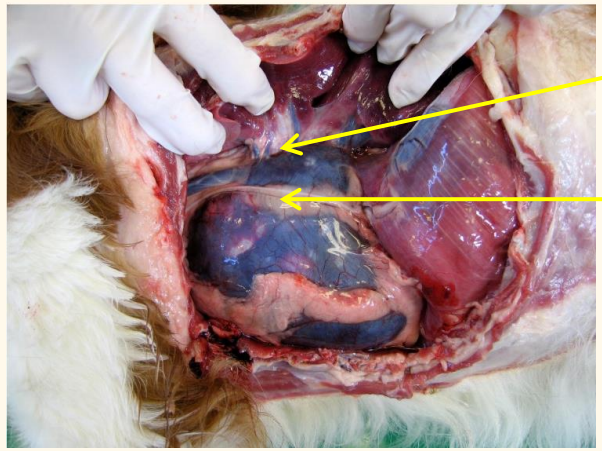
- Can have innocent/physiological murmurs commonly
- Compression of the thorax can cause a murmur
- Cats with severe heart disease may have no murmur
- Dynamic murmur does not help to differentiate
- Grade of murmur may not correlate with severity of disease
- Localisation is difficult
- Purring can be an issue

Gallop sound or arrhythmia is more specific (but less sensitive) for detecting heart disease in cats

Heart Rate and Arrhythmias

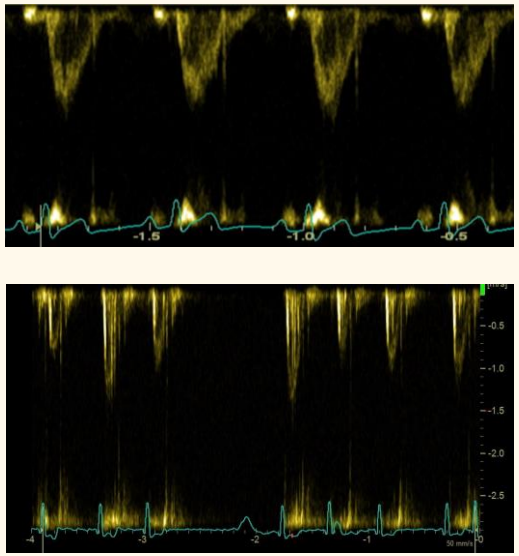
Heart Rate

- Heart rate increases during and just before CHF
- Respiratory sinus arrhythmia is unlikely in congestive heart failure
- ECG if HR <60bpm

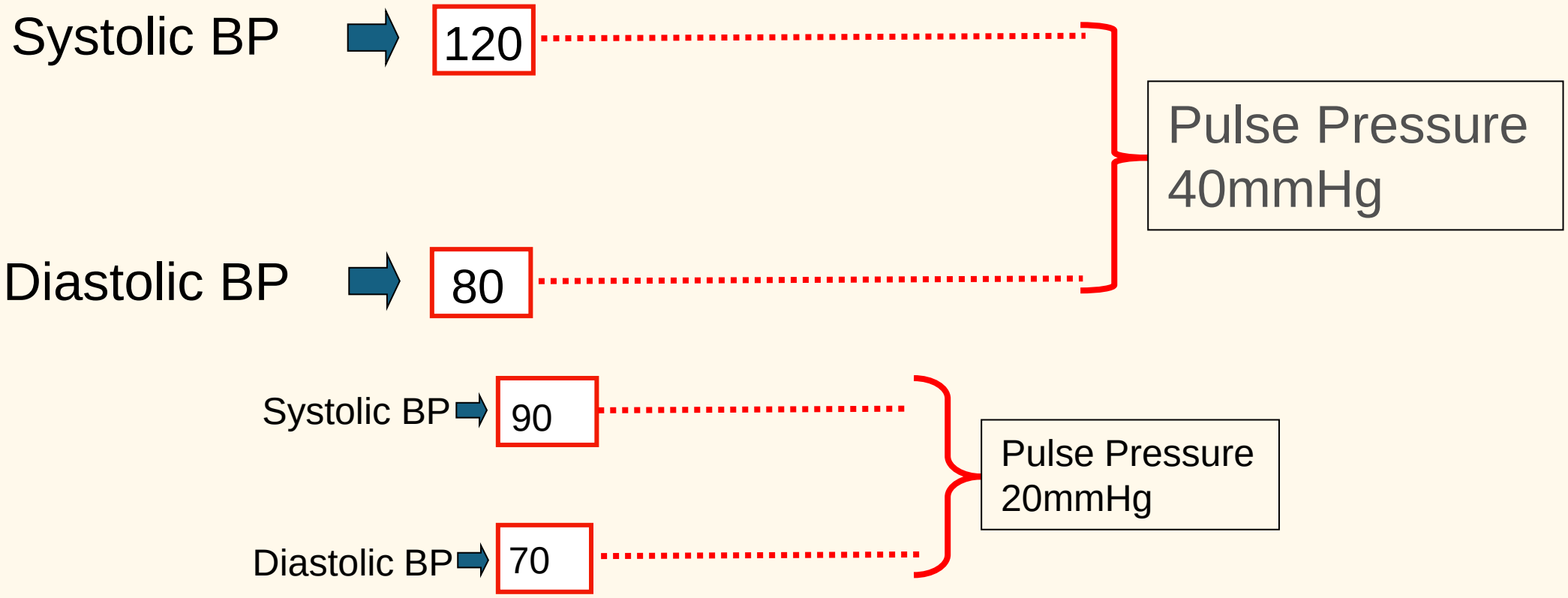


Arrhythmias

- Pulse deficits
- Cardiac disease vs. systemic disease



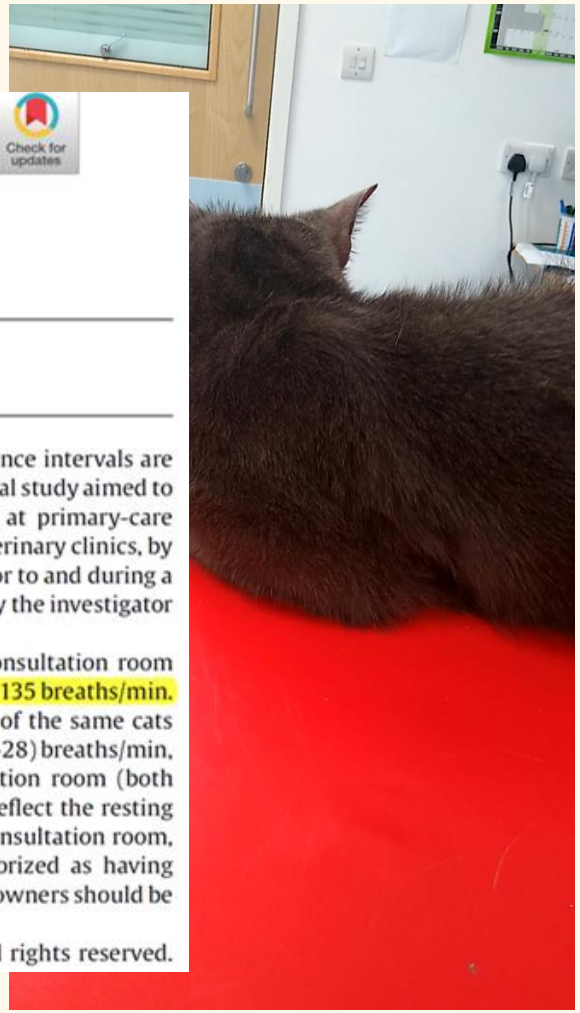
Pulse Quality



Forward failure is much less common than backwards (congestive) failure

Dyspnoea

- Pulmona
  - Redu
  - Inters
  - Hypo
- Pleural e
  - Muffl
  - Redu
- Fast, shallow breathing



Respiratory rate of clinically healthy cats measured in veterinary consultation rooms

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Physiologic
Reference
Video

ABSTRACT

Respiratory rate is commonly recorded during physical examinations. However, reference intervals are only available for resting and sleeping respiratory rates in cats at home. This observational study aimed to establish reference intervals for the respiratory rate in clinically healthy adult cats at primary-care veterinary clinics. Respiratory rates were recorded from 131 cats, in 6 primary-care veterinary clinics, by observation under four circumstances: by the investigator in the consultation room prior to and during a physical examination, by the owner at home when the cat was resting or sleeping, and by the investigator when watching a video-film of the cat recorded by the owner at home.

The respiratory rate of the 88 clinically healthy adult (≥12 months) cats in the consultation room ranged 28–176 breaths/min (median 64) with a calculated reference interval of 32–135 breaths/min. Based on video-recordings, the resting ($n = 32$) and sleeping ($n = 38$) respiratory rates of the same cats were determined: median 27 (range 16–60) breaths/min and median 20 (range 9–28) breaths/min, respectively, which were lower than the respiratory rates recorded in the consultation room (both $P < 0.0001$). We conclude that the reference intervals proposed for cats in textbooks reflect the resting respiratory rate at home. These values are inappropriate for using in the veterinary consultation room, because based on such reference intervals, many cats would erroneously be categorized as having tachypnea. Since the resting and sleeping respiratory rates at home show less variation, owners should be encouraged to film their pets before they visit their veterinarian.

Lung Auscultation

- Crackles
  - Do not have to be present with CHF
  - Do not always mean CHF
- Thoracic percussion

Right-sided Congestive Heart Failure

Blood-based biomarkers

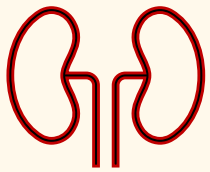
Natriuretic Peptides

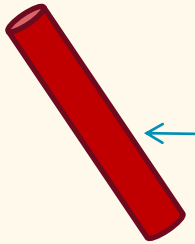
Preprohormone (stored) → **Pro**hormone (proANP, proBNP)

Cleaved once released

C-terminal
- C-BNP, C-ANP
- Active

N-terminal
- NT-proBNP, NT-proANP
- Inactive





NPR-A receptor
- Natriuresis
- Vasodilation
- Inhibit RAAS
- **Overall effect is to reduce blood volume and blood pressure**

Measured as biomarker

Renin Angiotensin

NT proBNP assay

- First generation
  - EDTA plasma, frozen.
- Second generation
  - EDTA plasma, not frozen unless >48 hours delay.
- POC snap test (cats)
  - Serum or EDTA plasma.
  - Results in 10 minutes so more practical.
  - Becomes positive between 100-200pmol/l.

Feline Cardiopet® proBNP Assay
SNAP® Feline proBNP, IDEXX Laboratories Inc., Westbrook (ME)

NT-proBNP	Lighter	Equal	Darker
			
Evaluation	Normal	Abnormal	Abnormal
NT-proBNP concentration (pmol/L)	24 (24-31)[a]	162 (100-217)[b]	505 (336-1312)[c]
No of POCT	108	6	25

Effect of feline characteristics on plasma N-terminal-prohormone B-type natriuretic peptide concentration and comparison of a point-of-care test and an ELISA test. Veterinary Internal Medici ne, Volume: 34, Issue: 3, Pages: 1187-1197, First published: 22 March 2020, DOI: (10.1111/jvim.15754)

J Vet Intern Med 2014;28:451–457

Breed Differences in Natriuretic Peptides in Healthy Dogs

K. Sjöstrand, G. Wess, I. Ljungvall, J. Häggström, A-C. Merveille, M. Wiberg, V. Gouni, J. Lundgren Willesen, S. Hanås, A-S. Lequarré, L. Mejer Sørensen, J. Wolf, L. Tiret, M. Kierczak, S. Forsberg, K. McEntee, G. Battaille, E. Seppälä, K. Lindblad-Toh, M. Georges, Hannes Lohi, V. Chetboul, M. Fredholm, and K. Höglund

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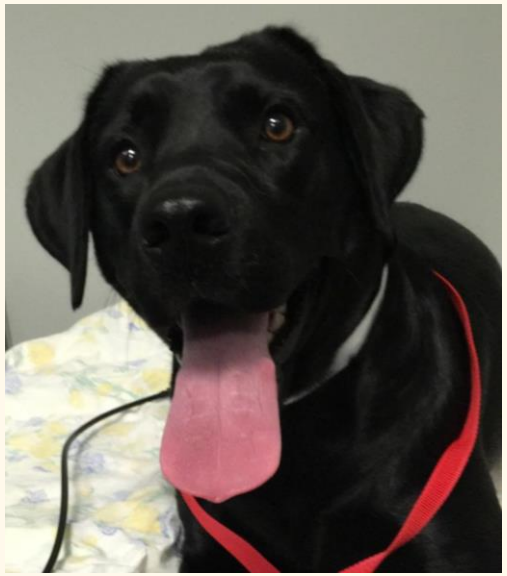

- Labs and Newfoundland highest (3X higher than Dachshunds)
- Dachshunds lowest

Sjöstrand K, Wess G, Ljungvall I, Häggström J, Merveille AC, Wiberg M, Gouni V, Lundgren Willesen J, Hanås S, Lequarré AS, Mejer Sørensen L, Wolf J, Tiret L, Kierczak M, Forsberg S, McEntee K, Battaille G, Seppälä E, Lindblad-Toh K, Georges M, Lohi H, Chetboul V, Fredholm M, Höglund K. Breed differences in natriuretic peptides in healthy dogs. J Vet Intern Med. 2014 Mar-Apr;28(2):451-7.

Journal of Veterinary Cardiology (2017) 19, 124–131

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Journal of Veterinary Cardiology
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Biologic variability of N-terminal pro-brain natriuretic peptide in healthy dogs and dogs with myxomatous mitral valve disease

Randolph L. Winter, DVM [a,*], Ashley B. Saunders, DVM [a], Sonya G. Gordon, DVM, DVSc [a], Jesse S. Buch, PhD [b], Matthew W. Miller, DVM, MS [a]

28 dogs with MMVD and 10 healthy controls.

NTproBNP was measured hourly, daily, and weekly x 6 wk (272 observations)

	BNP (pmol/L)	CCV – 95%
Healthy (n=10)	543 (16 – 1,558)	70.8% (62.3 - 82.1%)
MMVD B1 (n=10)	677 (24 - 1,344)	73.4% (64.6 - 85.2%)
MMVD B2 (n=10)	1,553 (531 – 3,010)	51.4% (45.2 - 59.6%)
MMVD C – stable (N=8)	1,963 (424 – 4,086)	53.3% (46.9 - 61.9%)
All MMVD (n=28)		58.2% (51.2 - 67.5%)

CCV - Critical Change Value: change that can be attributed to progression of disease vs. biological variability

Biologic variability of N-terminal pro-brain natriuretic peptide in adult healthy cats

Journal of Feline Medicine and Surgery
2017, Vol. 19(2) 216–223

DOI: 10.1177/1098612X15623825
jfms.com
SAGE

Autumn N Harris[1], Amara H Estrada[1], Alexander E Gallagher[1], Brandy Winter[1], Kenneth E Lamb[2], Mary Bohannon[1], Jancy Hanscom[3] and Celine A Mainville[3]

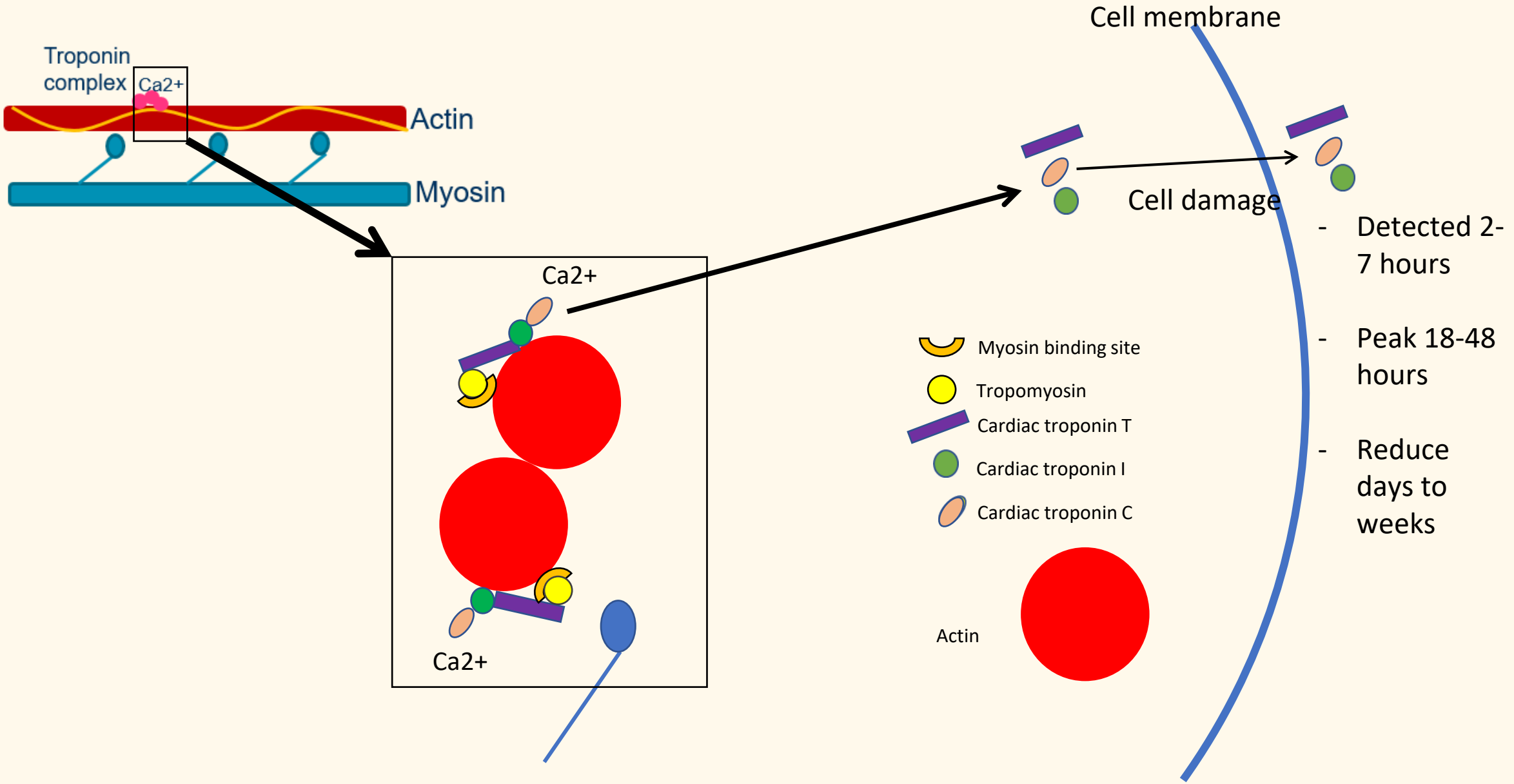
A change of **39.8%** between days and **60.5%** between weekly measurements is required to be considered significant in the cat

Males higher NT-proBNP than females

Comorbid conditions

- **Renal disease** (seems to be associated with related hypertension rather than reduced GFR)
- **Systemic hypertension**
- **Hyperthyroidism**
- **Pulmonary hypertension** (cor pulmonale)

Cardiac troponins



- Detected 2-7 hours
- Peak 18-48 hours
- Reduce days to weeks

Available assays

- Over 15 different assays with antibodies to different isotopes
- In theory shouldn’t compare measurements from different assays
- Not all validated for veterinary use

Comorbid conditions

- **Renal disease** (reduced GFR)
- **Systemic inflammatory disease** (cytokines, oxidative damage)
- **Hypoxia**

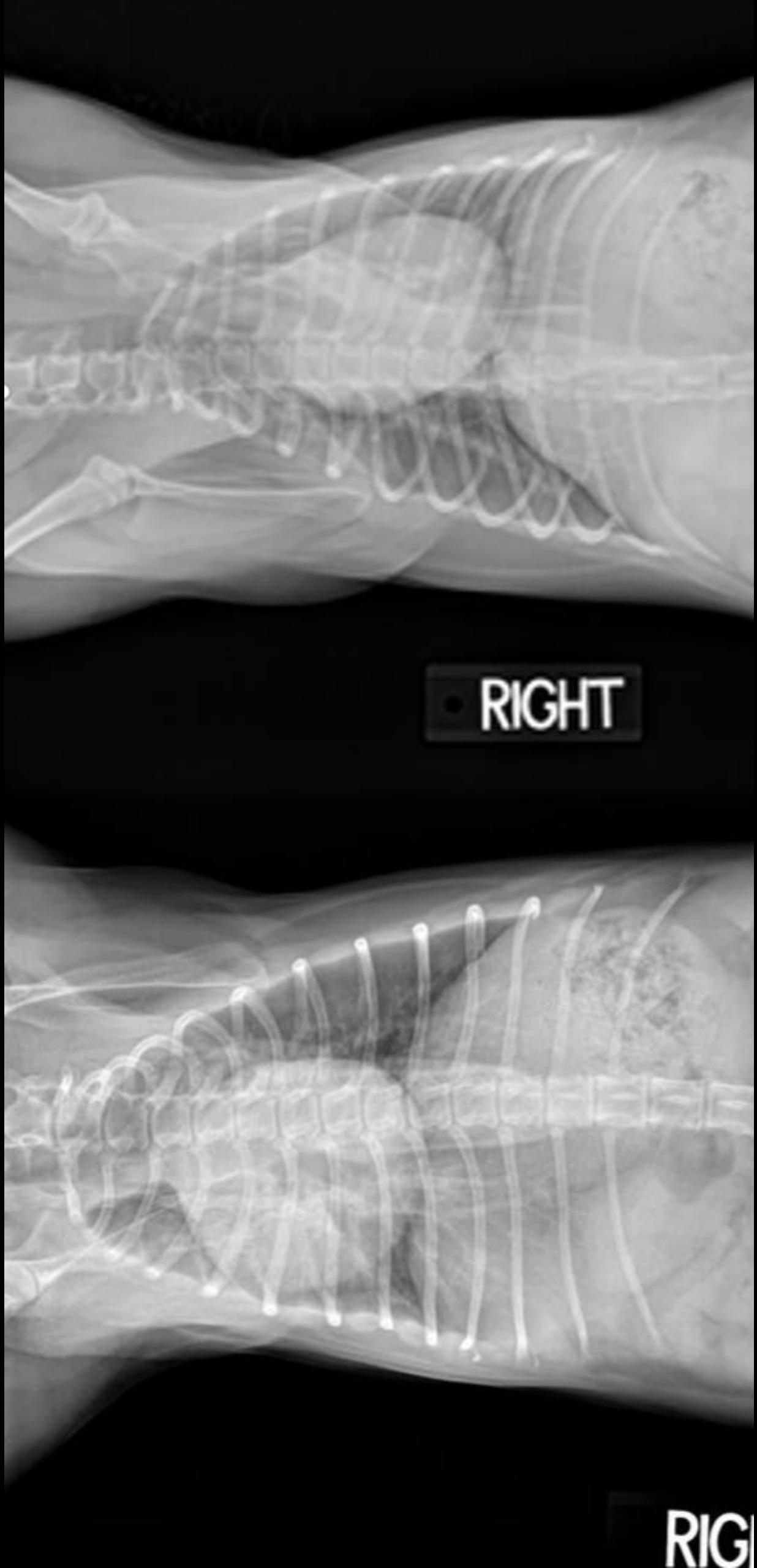
Radiographs

Helpful Reminders

- Three view thorax is standard (RL / LL / DV or VD)
- Adequate positioning and technique is very important
- Only detects cardiomegaly, not cardiac disease
- **Radiographs diagnose LCHF, not echocardiography**

A Note on Positioning and Technique

Same Dogs, Same day


RIGHT
RIG

VHS in different dog breeds

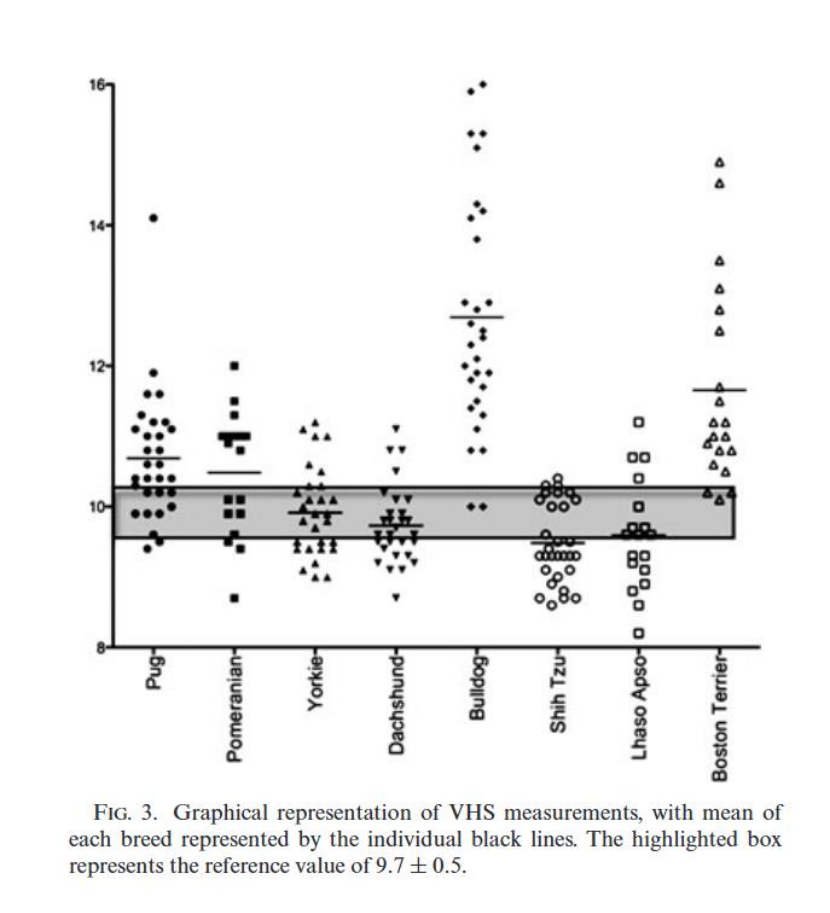
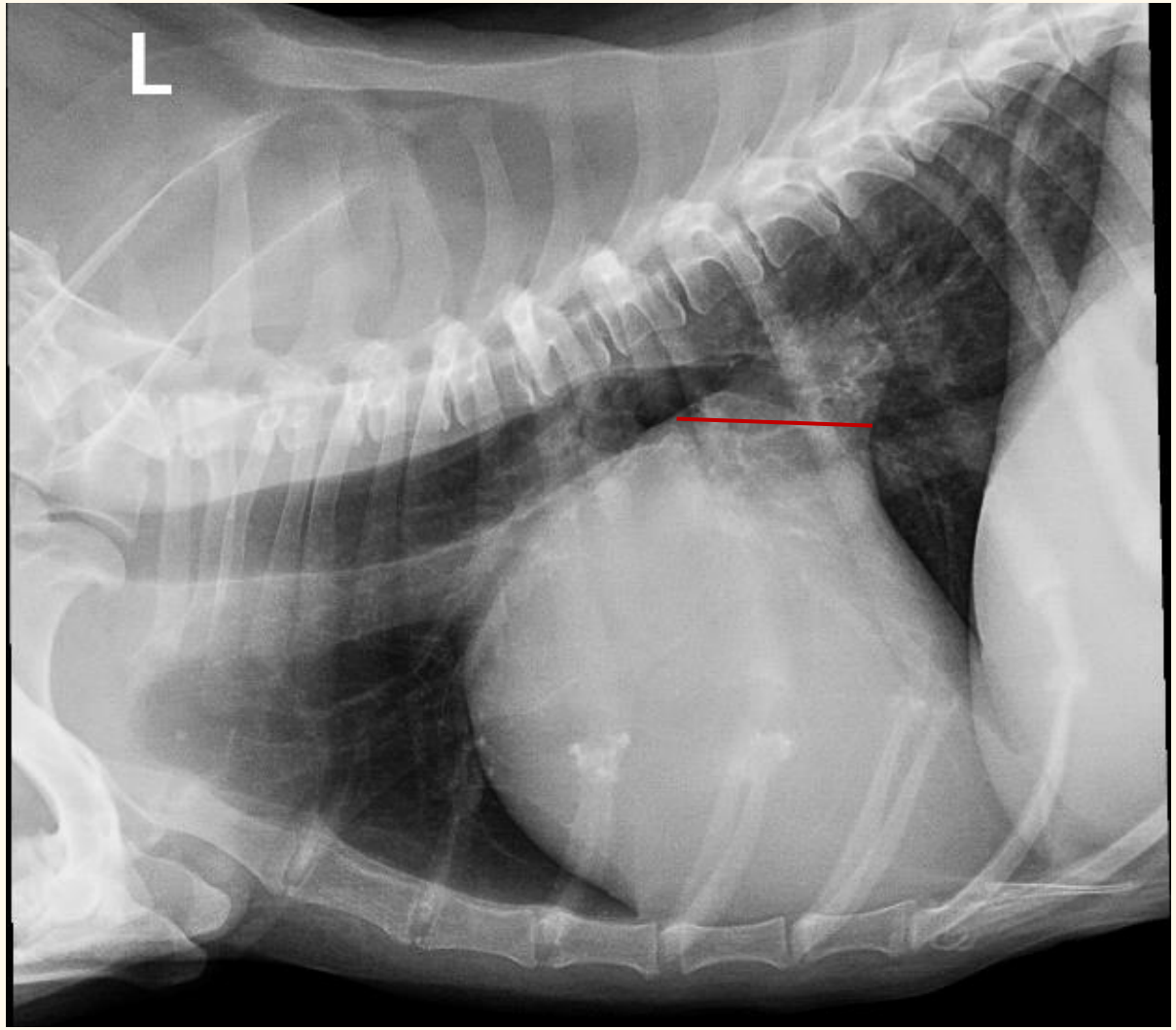


FIG. 3. Graphical representation of VHS measurements, with mean of each breed represented by the individual black lines. The highlighted box represents the reference value of 9.7 ± 0.5.

Jepsen-Grant K, Pollard RE, Johnson LR. Vertebral heart scores in eight dog breeds. Vet Radiol Ultrasound. 2013 Jan-Feb;54(1):3-8. doi:10.1111/j.1740-8261.2012.01976.x. Epub 2012 Sep 21.

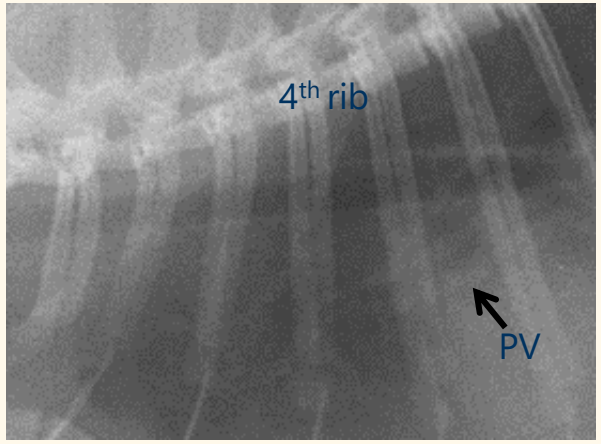
PMID:22994206.

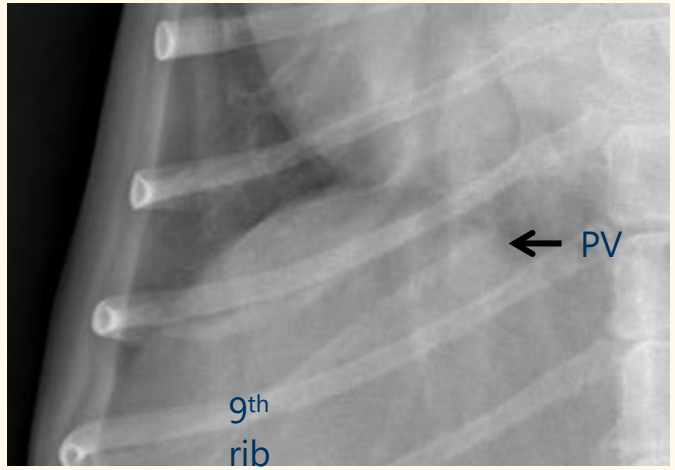
VLAS



Pulmonary veins

- Lateral view – not wider than proximal 1/3 of 4th rib
- DV view – not wider than 9th rib where they cross
- Can be difficult to detect in some cats





Lungs

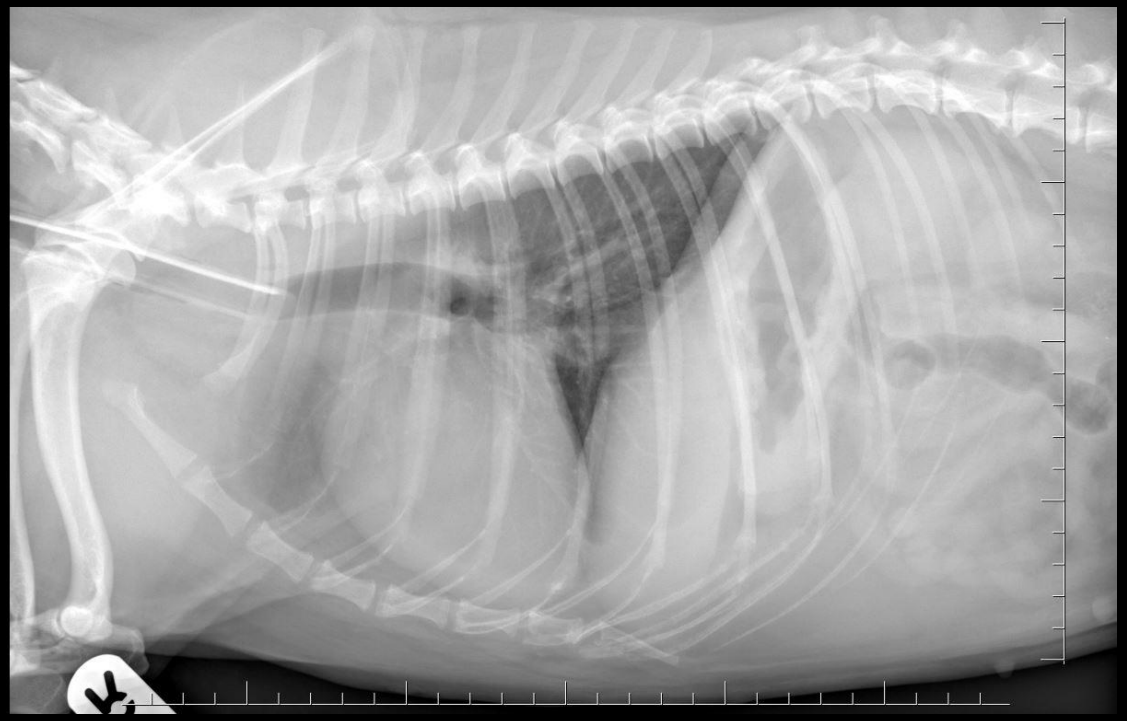
- **Dogs:** Perihilar pulmonary oedema (except Doberman)
- **Cats:**
  - Pulmonary oedema can be non-uniform
  - Pleural effusion can mask everything else – should TFAST first
  - Pulmonary venous distention can be difficult to detect.

Cat

8mnth Doberman

8yr CKCS

Baseline

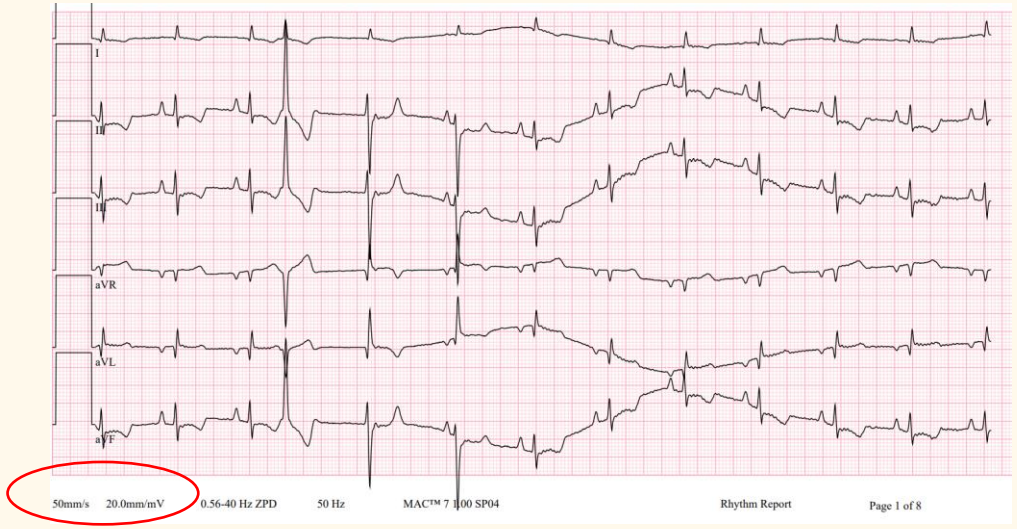


LCHF

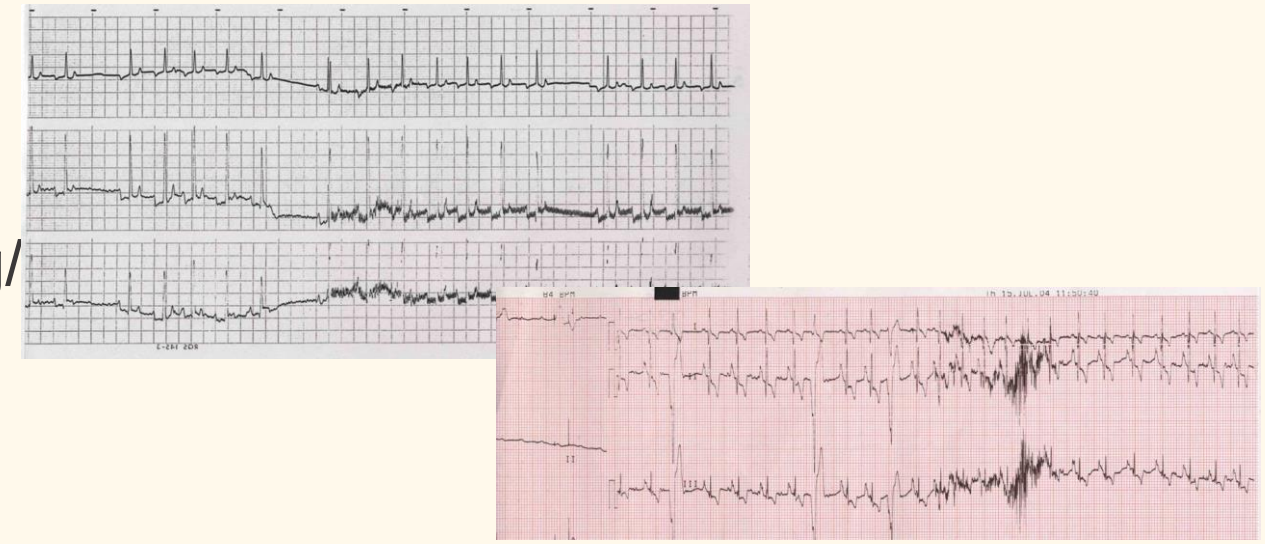
ECG

Helpful Reminders

- Lead II for measurements
  - 50mm/s and 10mm/mV
  - Can change settings if needed



- Good quality trace with little/ no artefact
  - Movement/ electrical/ purring/ respiration



Helpful Reminders

- ECGs are diagnostic for **heart rate and rhythm**
- Only supportive of / suggestive of cardiac chamber enlargement
- ECG axis only valid if the patient is in right lateral recumbency AND if the clips are applied to the correct limbs.

Arrhythmias are often intermittent

- AliveCor
- Holter monitoring

Echocardiography

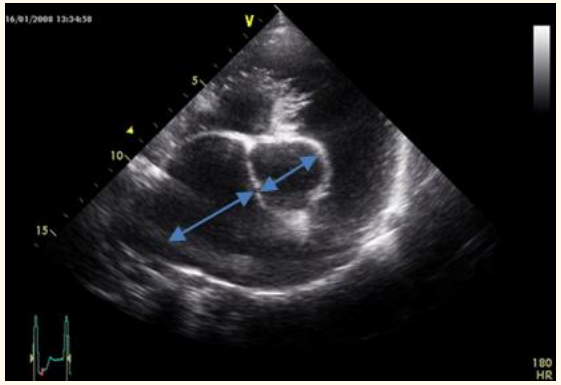
What about echo in practice?

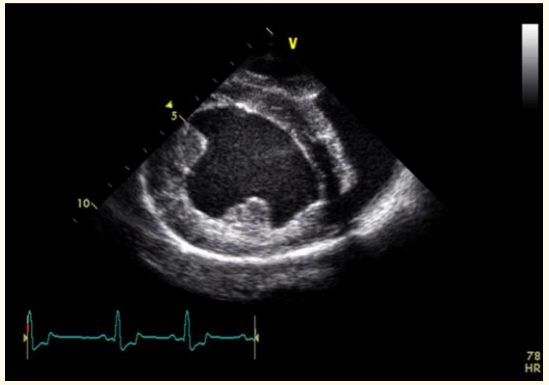
J Vet Emerg Crit Care (San Antonio). 2013 May-Jun;23(3):268-73. doi: 10.1111/vec.12056. Epub 2013 May 6.

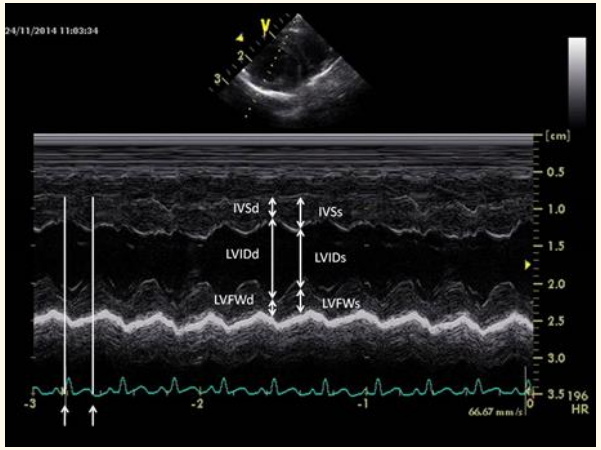
Evaluation of a training course in focused echocardiography for noncardiology house officers.

Tse YC[1], Rush JE, Cunningham SM, Bulmer BJ, Freeman LM, Rozanski EA.

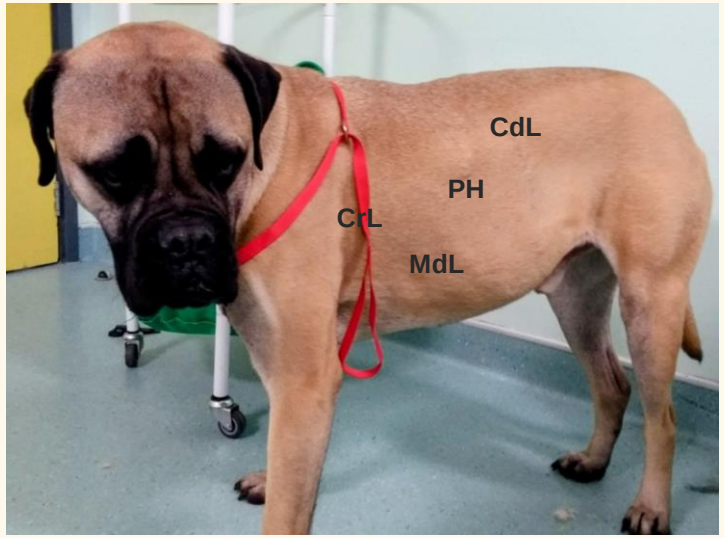
- Good at detecting
  - Pleural effusion
  - Pericardial effusion
  - Big vs. normal left atrial size
- Not so good at accurately assessing
  - Cardiac masses
  - Volume status
  - Ventricular enlargement or hypertrophy
  - Congenital heart disease

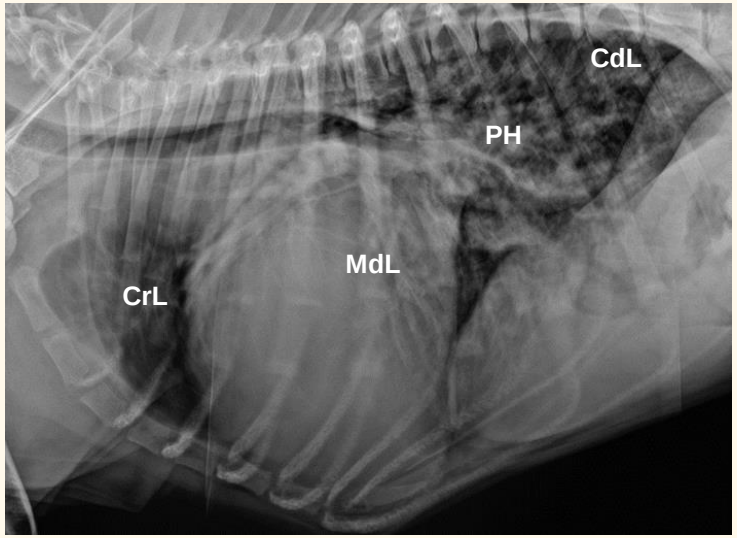


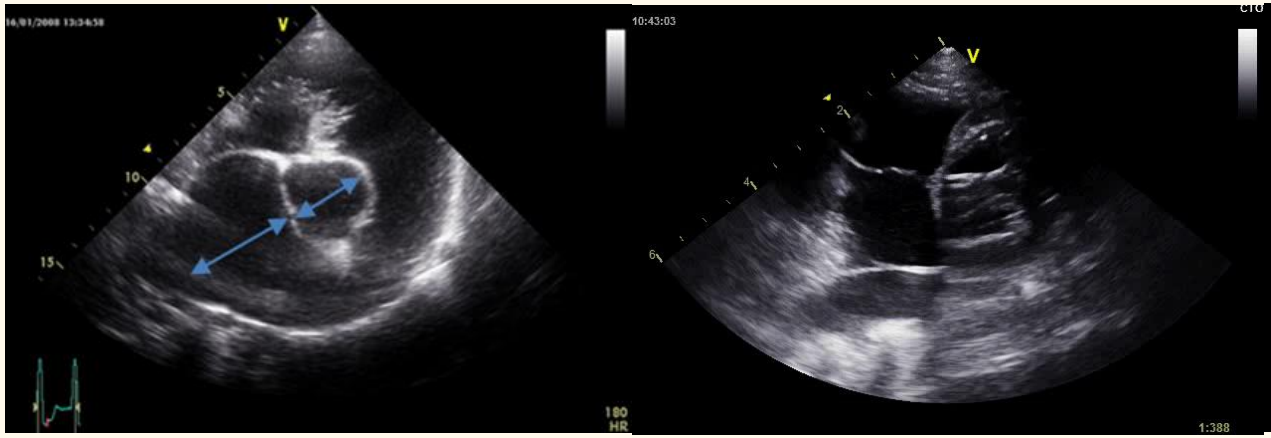


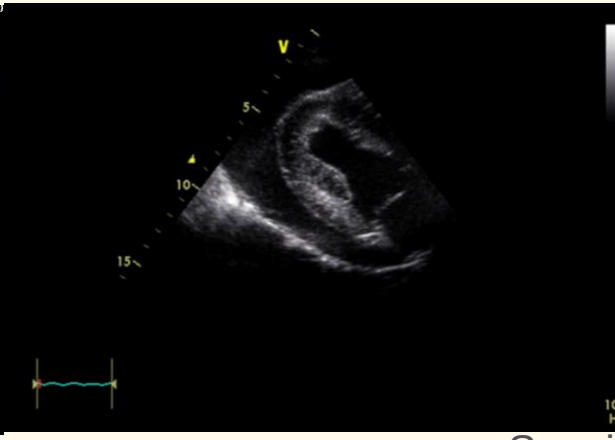


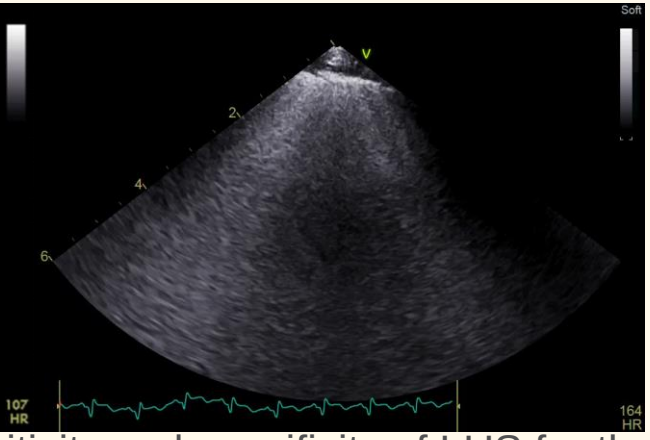
POCUS









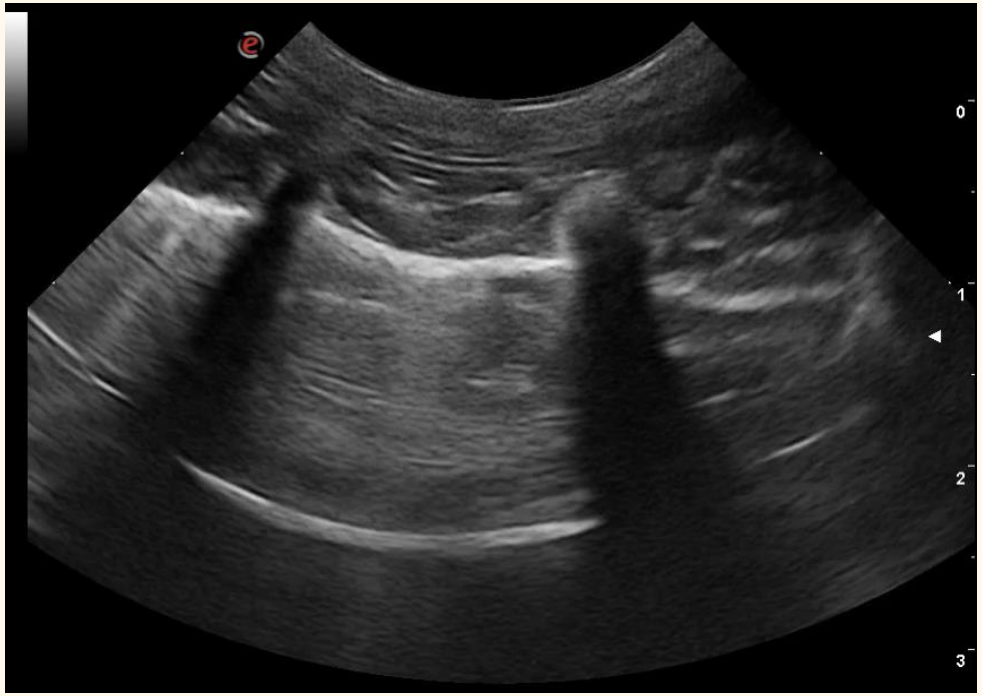


Sensitivity and specificity of LUS for the diagnosis of CPE were 84% and 74%.

Sonographic machine-assisted recognition and tracking of B-lines in dogs: the SMARTDOG study

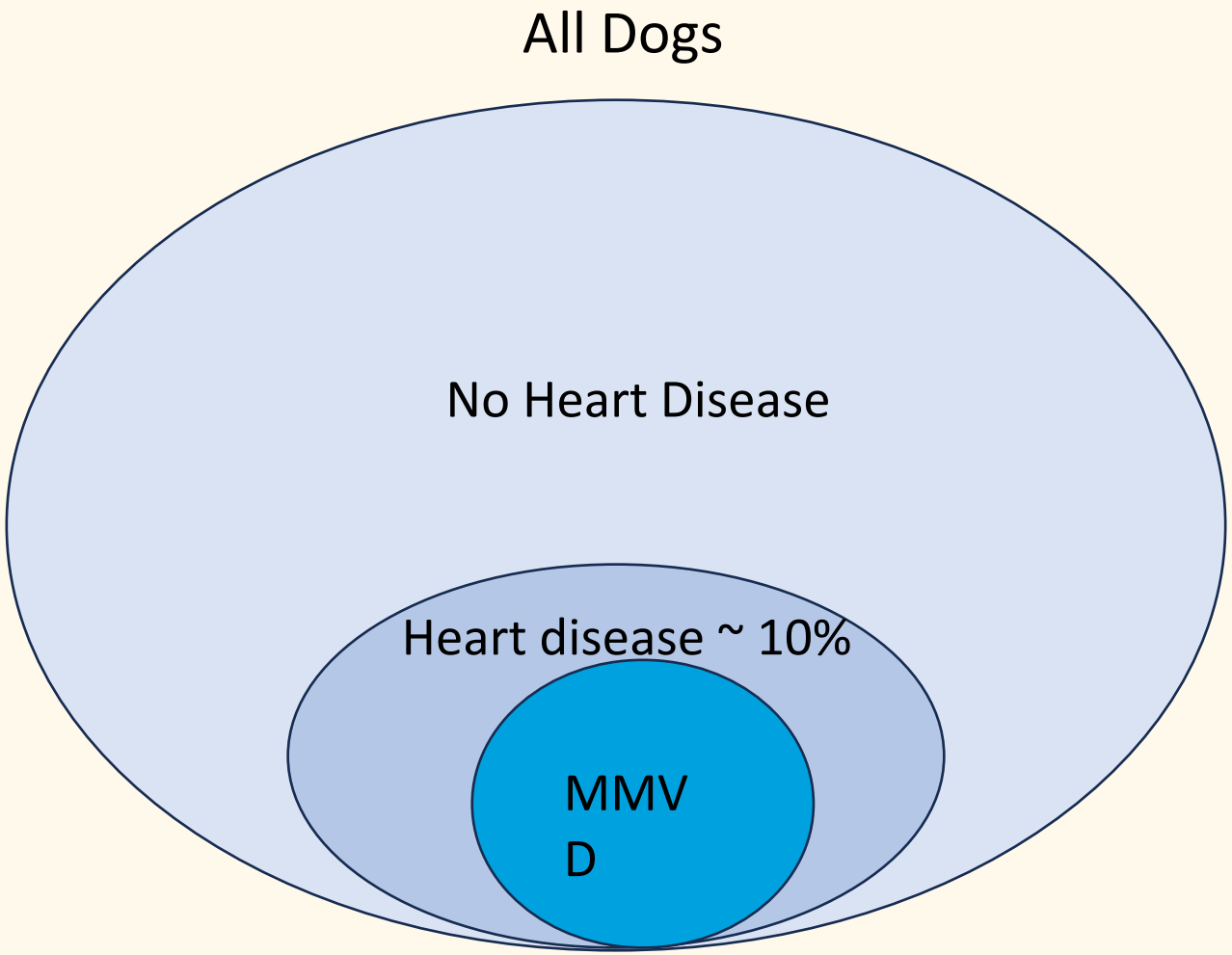
Aurélie Jourdan[1,2]*, Caroline Dania[1,2] and Maxime Cambournac[1,2]

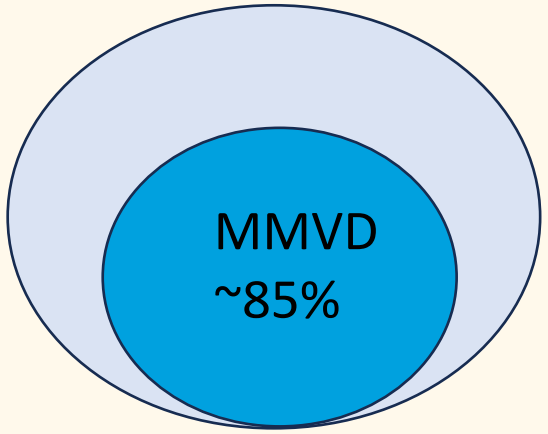
Front. Vet. Sci., 08 August 2025
Sec. Veterinary Emergency and Critical Care Medicine
Volume 12 - 2025
| https://doi.org/10.3389/fvets.2025.1647547



Myxomatous Mitral Valve Disease

Prevalence of Heart Disease in Dogs





Keene BW, Atkins CE, Bonagura JD, et al. ACVIM consensus guidelines for the diagnosis and treatment of myxomatous mitral valve disease in dogs. *J Vet Intern Med*. 2019; 33: 1127–1140. https://doi.org/10.1111/jvim.15488

Buchanan JW. Chronic valvular disease (endocardiosis) in dogs. *Adv Vet Sci Comp Med*. 1977; **21**: 75-106

ACVIM Consensus Statement

- **Stage A**: High risk for developing heart disease
  - CKCS, Dachshunds, Poodles, all small breed dogs
- **Stage B**: Structural heart disease but no clinical signs
  - B1: No remodeling
  - B2: Remodeling defined as LAE and LV dilation (LA:Ao, LVIDdN, VHS)
- **Stage C:** Past or current clinical signs of CHF
- **Stage D**: End stage disease. CHF refractory to 'standard therapy'

Criteria for Stage B2 Disease

J Vet Intern Med 2016;30:1765–1779

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

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

Background: Pimobendan is effective in treatment of dogs with congestive heart failure (CHF) secondary to myxomatous mitral valve disease (MMVD). Its effect on dogs before the onset of CHF is unknown.

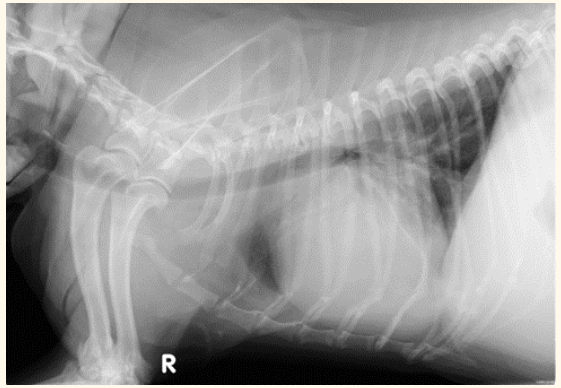
Hypothesis/Objectives: Administration of pimobendan (0.4–0.6 mg/kg/d in divided doses) to dogs with increased heart size secondary to preclinical MMVD, not receiving other cardiovascular medications, will delay the onset of signs of CHF, cardiac-related death, or euthanasia.

Animals: 360 client-owned dogs with MMVD with left atrial-to-aortic ratio ≥1.6, normalized left ventricular internal diameter in diastole ≥1.7, and vertebral heart sum >10.5.

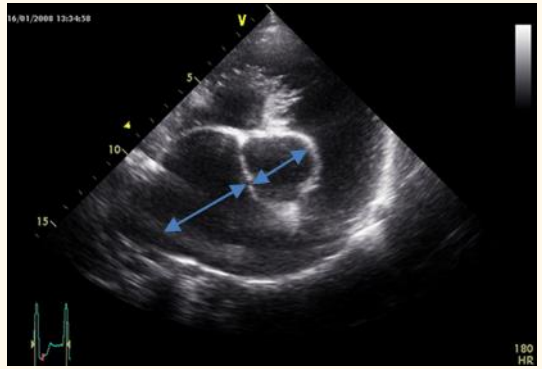
Methods: Prospective, randomized, placebo-controlled, blinded, multicenter clinical trial. Primary outcome variable was time to a composite of the onset of CHF, cardiac-related death, or euthanasia.

Results: Median time to primary endpoint was 1228 days (95% CI: 856–NA) in the pimobendan group and 766 days (95% CI: 667–875) in the placebo group ($P = .0038$). Hazard ratio for the pimobendan group was 0.64 (95% CI: 0.47–0.87) compared with the placebo group. The benefit persisted after adjustment for other variables. Adverse events were not different between treatment groups. Dogs in the pimobendan group lived longer (median survival time was 1059 days (95% CI: 952–NA) in the pimobendan group and 902 days (95% CI: 747–1061) in the placebo group) ($P = .012$).

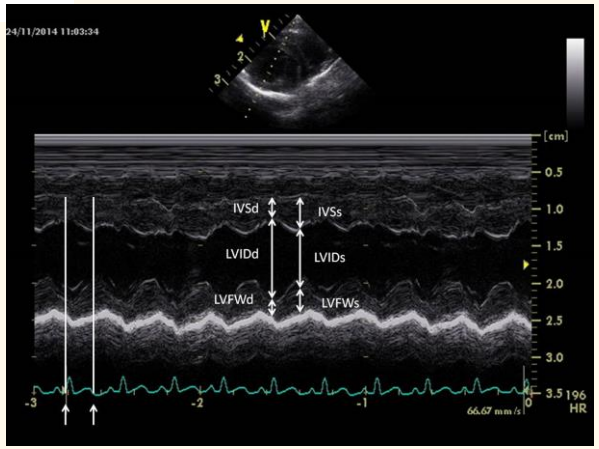
Conclusions and Clinical Importance: Administration of pimobendan to dogs with MMVD and echocardiographic and radiographic evidence of cardiomegaly results in prolongation of preclinical period and is safe and well tolerated. Prolongation of preclinical period by approximately 15 months represents substantial clinical benefit.



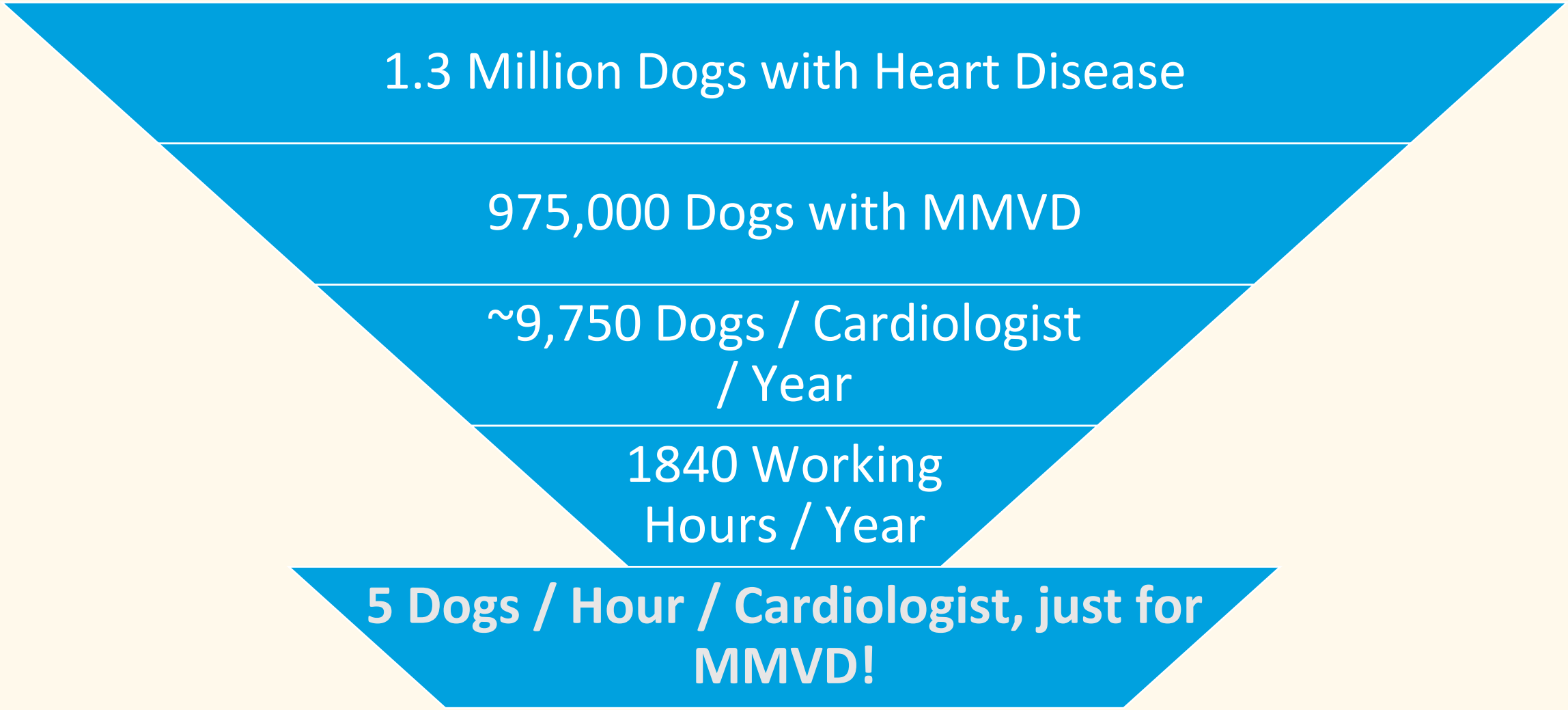
VHS>10.5v



LA:Ao≥1.6



LVIDDN≥1.7


1.3 Million Dogs with Heart Disease
975,000 Dogs with MMVD
~9,750 Dogs / Cardiologist / Year
1840 Working Hours / Year
5 Dogs / Hour / Cardiologist, just for MMVD!

Which dogs to screen?

- **Breed**
- **Age**
- **Heart murmur**
  - Grade I or II/VI suggests disease is likely stage B1
  - ≥ Grade III/VI murmur is one of the criteria for stage B2 disease

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

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

J Vet Intern Med. 2019; 33: 1127– 1140

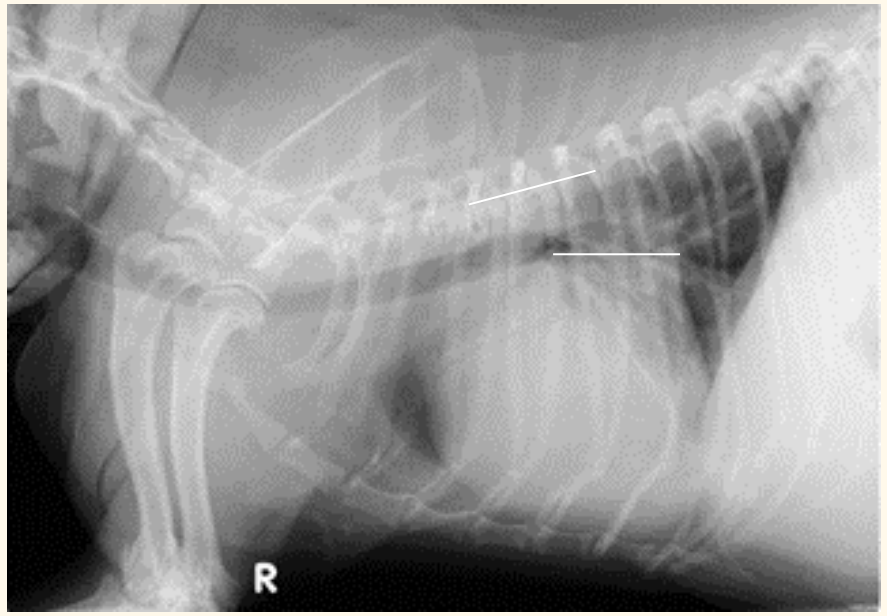
"In the absence of echocardiographic measurements, clear radiographic evidence of cardiomegaly (eg, a general breed ***VHS≥11.5****, or a comparable breed-adjusted VHS in cases where breed-specific VHS normal values are available)* ***or evidence of accelerating (increasing) interval change*** *in radiographic or echocardiographic cardiac enlargement patterns can substitute for quantitative echocardiography to identify Stage B2.* ***(LOE expert opinion)"***

VLAS

- Malcolm, EL et al., *JAVMA* 2018;253(8):1038-1045.
  - **VLAS ≥ 2.3** vertebrae was a useful predictor of LA enlargement

- Mikawa S et al., *J Vet Cardiol* 2020;30:92-99.
  - **VLAS ≥ 2.6** provided the greatest diagnostic accuracy for identification of dogs with ACVIM stage B2 MMVD
  - **VLAS ≥ 2.5** exhibited the highest sensitivity
  - **VLAS ≥ 3.1** exhibited the highest specificity

- Stepien RL et al., *JAVMA* 2020;256(10):1129-1136.
  - **VLAS ≥ 2.5** greatest accuracy
  - **VLAS ≥ 3** highest specificity



Accuracy of history, physical examination, cardiac biomarkers, and biochemical variables in identifying dogs with stage B2 degenerative mitral valve disease

Jenny Wilshaw[1] | Steven L. Rosenthal[2] | Gerhard Wess[3] | Dave Dickson[4] | Luca Bevilacqua[5] | Emily Dutton[6] | Michael Deinert[7] | Ricardo Abrantes[8] | Ingo Schneider[9] | Mark A. Oyama[10] | Sonya G. Gordon[11] | Jonathan Elliott[12] | Dong Xia[13] | Adrian Boswood[1]

J Vet Intern Med. 2021; 35: 755– 770

- **NT-proBNP↑**
- Murmur intensity↑
- Appetite↓
- Body condition ≤3
- Serum creatinine concentration ↓

- Age 8-10 years
- Serum ALT↑

Use of physical examination, electrocardiography, radiography, and biomarkers to predict echocardiographic stage B2 myxomatous mitral valve disease in preclinical Cavalier King Charles Spaniels☆

S. Wesselowski, DVM, MS[a,*], S.G. Gordon, DVM, DVSc[a], R. Fries, DVM[b], A.B. Saunders, DVM[a], K.T. Sykes, DVM[a], J. Vitt, DVM[b], B. Boutet, DVM[c], J. Häggström, DVM[d], S. Kadotani, DVM, MS[b], J. Stack, DVM[b], B.G. Barnett, DVM[a]

J Vet Cardiol. 2023; 50: 1-16

- **NT-proBNP > 1138 pmol/L**
- **VHS > 11.5**

- Prediction models using multiple tests are best at discriminating (murmur grade, HR, p and QRS duration)

Summary for MMVD screening (B1 vs B2)

Gold standard

- Murmur grade
  - ≥ III/VI
- Echocardiography
  - LA:Ao ≥ 1.6
  - LVIDd ≥ 1.7
- Thoracic radiographs
  - VHS > 10.5v

Alternative

- Murmur grade
  - ≥ III/VI
- Thoracic radiographs
  - VHS > 11.6v
  - VLAS > 3.0v
- NT pro BNP
  - >1138 pmol/L

ACVIM Consensus Statement

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  - B1: No remodeling
  - B2: Remodeling defined as LAE and LV dilation (LA:Ao, LVIDdN, VHS)
- **Stage C:** Past or current clinical signs of CHF
- **Stage D**: End stage disease. CHF refractory to 'standard therapy'

Received: 5 December 2019 | Accepted: 27 February 2020

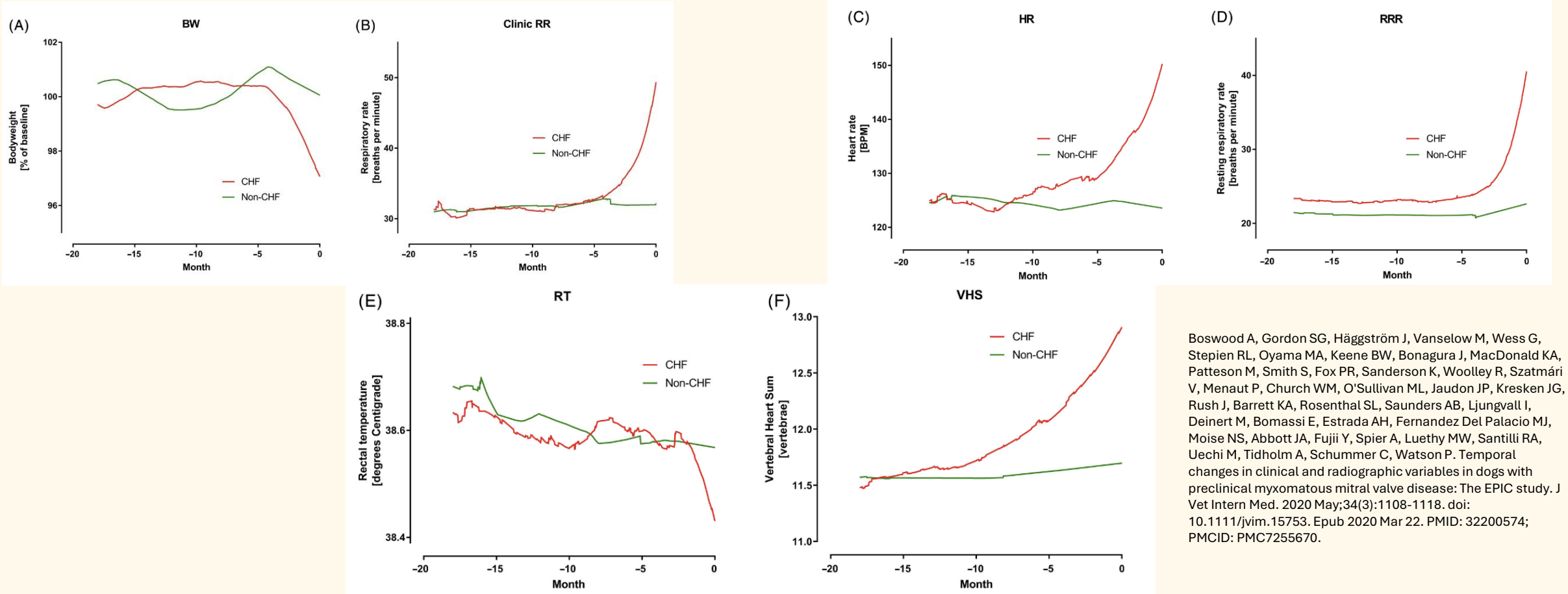
DOI: 10.1111/jvim.15753

STANDARD ARTICLE

Journal of Veterinary Internal Medicine Open Access

ACVIM American College of Veterinary Internal Medicine

Temporal changes in clinical and radiographic variables in dogs with preclinical myxomatous mitral valve disease: The EPIC study



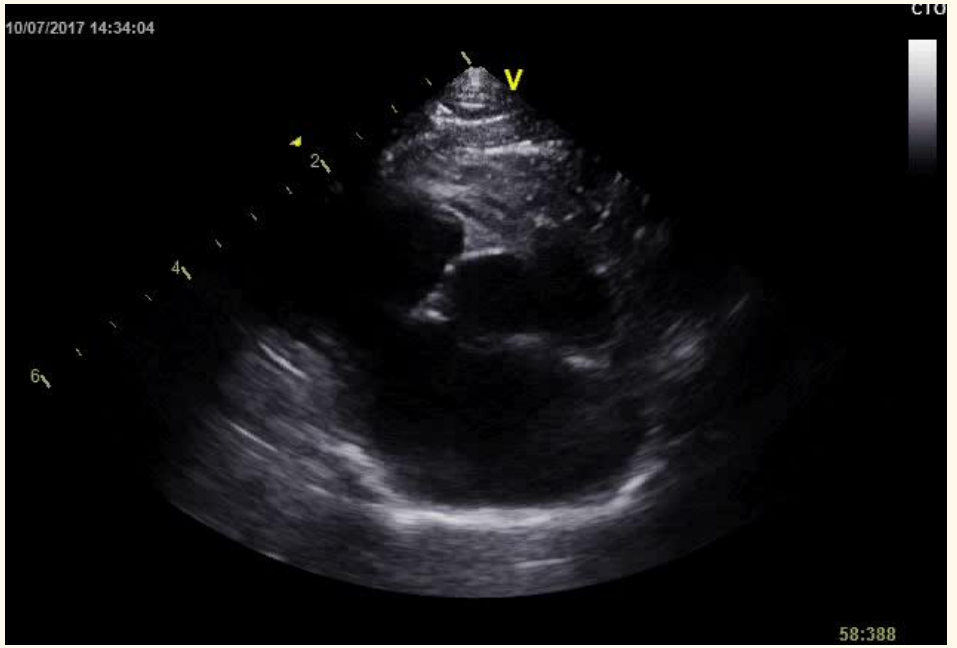
Boswood A, Gordon SG, Häggström J, Vanselow M, Wess G, Stepien RL, Oyama MA, Keene BW, Bonagura J, MacDonald KA, Patteson M, Smith S, Fox PR, Sanderson K, Woolley R, Szatmári V, Menaut P, Church WM, O'Sullivan ML, Jaudon JP, Kresken JG, Rush J, Barrett KA, Rosenthal SL, Saunders AB, Ljungvall I, Deinert M, Bomassi E, Estrada AH, Fernandez Del Palacio MJ, Moise NS, Abbott JA, Fujii Y, Spier A, Luethy MW, Santilli RA, Uechi M, Tidholm A, Schummer C, Watson P. Temporal changes in clinical and radiographic variables in dogs with preclinical myxomatous mitral valve disease: The EPIC study. J Vet Intern Med. 2020 May;34(3):1108-1118. doi: 10.1111/jvim.15753. Epub 2020 Mar 22. PMID: 32200574; PMCID: PMC7255670.

Biomarkers

- NT-proBNP
  - Optimal cut-off of **>2447 pmol/l** is 81.1% sensitive and 73.1% specific.
  - Current recommendation from IDEXX is that a value of **>1800 pmol/l** is highly suggestive of CHF in a patient presenting with appropriate signs.
- cTnI
  - Not very specific, not recommended

POCUS

- Lung ultrasound for pulmonary oedema
  - Positive predictive value 85.7%
  - Negative predictive value 95.2%



Dilated Cardiomyopathy

Which dogs to screen?

Start once 3 years old
Every 1-2 years

Primary DCM

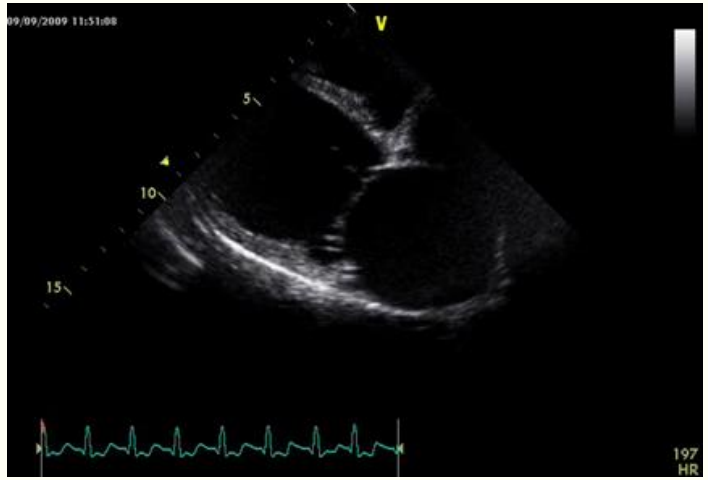
- Doberman 58.2%
- Newfoundland 17.6%
- Irish Wolfhound 24.2%
- Scottish Deerhound 21.6%
- Great Dane 35.6%
- Cocker Spaniel

Secondary DCM

- “BEG” diets – Boutique, Exotic, Grain-free
- Tachycardia induced
- Toxins (eg. doxorubicin)
- Endocrinopathies
- Infectious disease

Physical exam

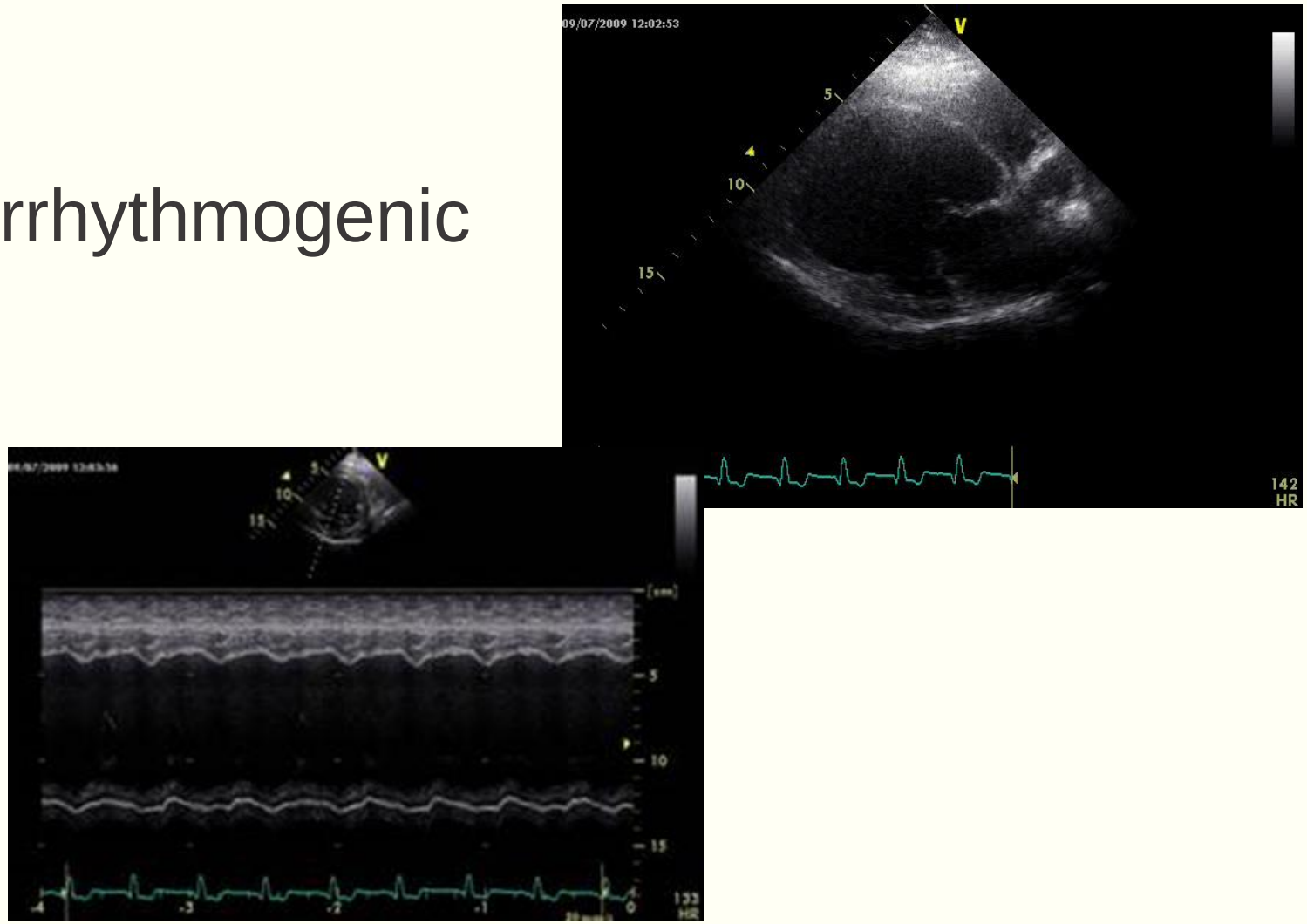
- Murmur
- Gallop
- Arrhythmia



- Often no physical exam findings with DCM

Echocardiography

- Gold standard
- May not detect arrhythmogenic DCM



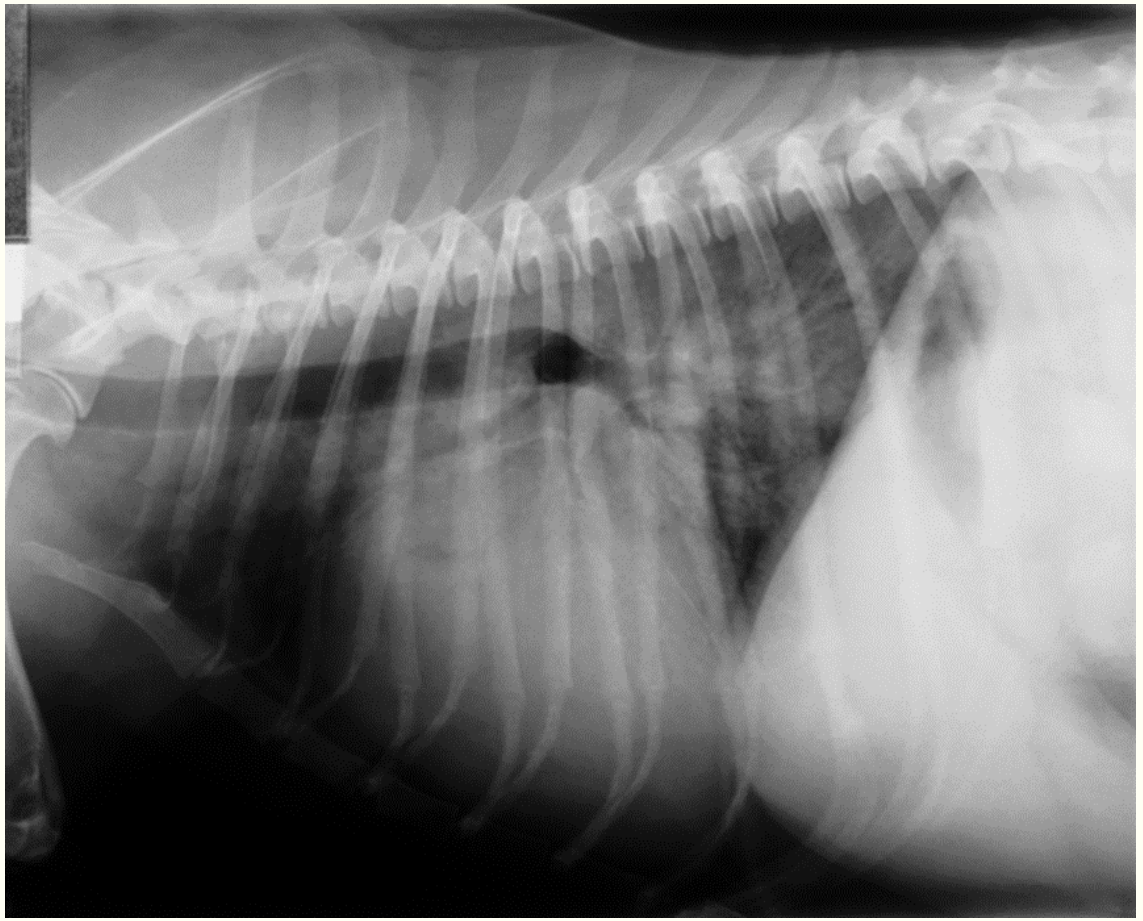
Holter monitor

- In combination with echocardiography
- Doberman: >300 VPCs in 24 hours or between 50-300 VPCs on two separate Holter monitors within a year.

- Rule out systemic disease

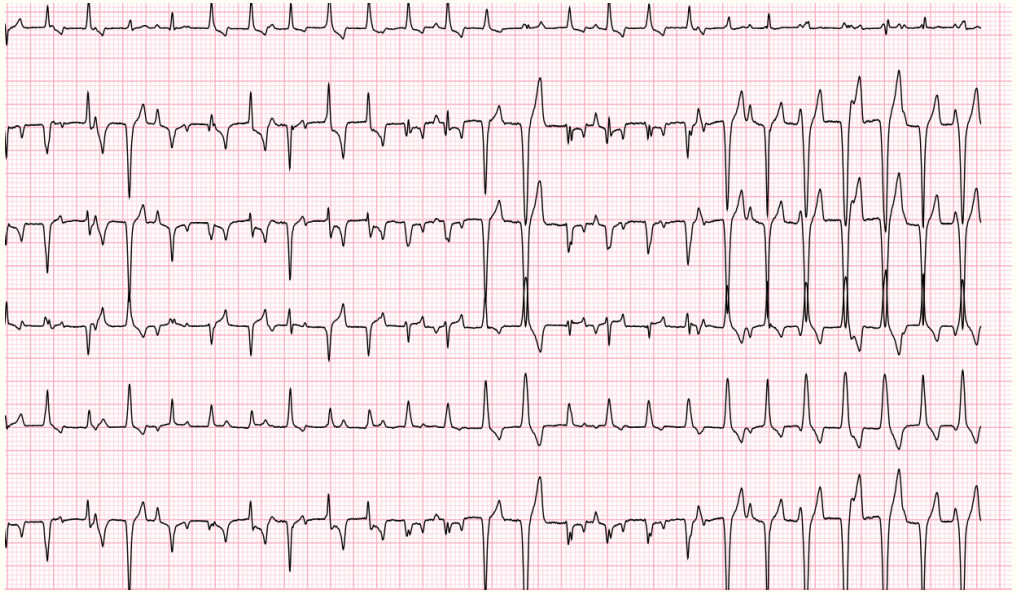
Thoracic radiographs

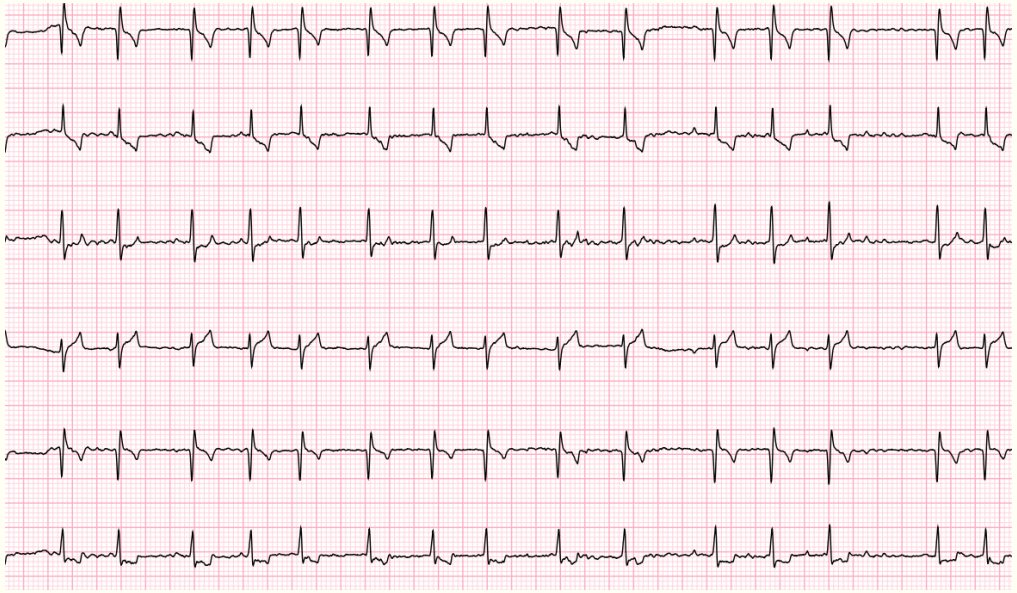
- Not very sensitive or specific for pre-clinical
- Diagnosis LCHF



ECG

One VPC in 5 minutes suggests >100 VPCs in 24 hours
PPV 85.6% NPV 89.9%
Prevalence of 23.3%





Blood-based biomarkers

- NT pro BNP
  - **>626 pmol/L**: PPV 72%, NPV 83% (Dukes-McEwan, J et al., *J Small Anim Pract* 2022;63:275-285)
  - **>550 pmol/L:** Sens 78.6%, spec 90.4% (Wess et al., JAVMA 2010;73(5))
  - **>400 pmol/L:** Sens 90.0%, spec 75.0% (Wess et al., JAVMA 2010;73(5))
  - Does not detect arrhythmic DCM
- Cardiac troponin I
  - **>0.22 ng/mL:** Sens 79.5%, spec 84.4%(Wess et al., J Vet Intern Med 2010;24:843-849)
  - **> 0.113 ng/mL:** Sens 81.2%, spec 73.2%(Kluser et al., J Vet Intern Med 2019;33:54-63)
  - **> 0.056 ng/mL:** Sens 84%, spec 84%(Dukes-McEwan et al., J Small Anim Pract 2022;63(4):275-285)

Genetic Screening

Useful as screening for breeding animals but not individual risk of development of DCM

PDK4 gene: US population
Titin gene
Others proposed

Several **SNPs**

By Udo Tjalsma - Own work, CC0, https://commons.wikimedia.org/w/index.php?curid=8960691

Phospholamban gene

User:Challkhmc, Public domain, via Wikimedia Commonshttps://commons.wikimedia.org/wiki/File:Portugueuse_Water_Dog_in_snow.jpg

Locus on **chromosome 8**

RNA-binding motif protein 20 gene

Summary for DCM

Gold standard

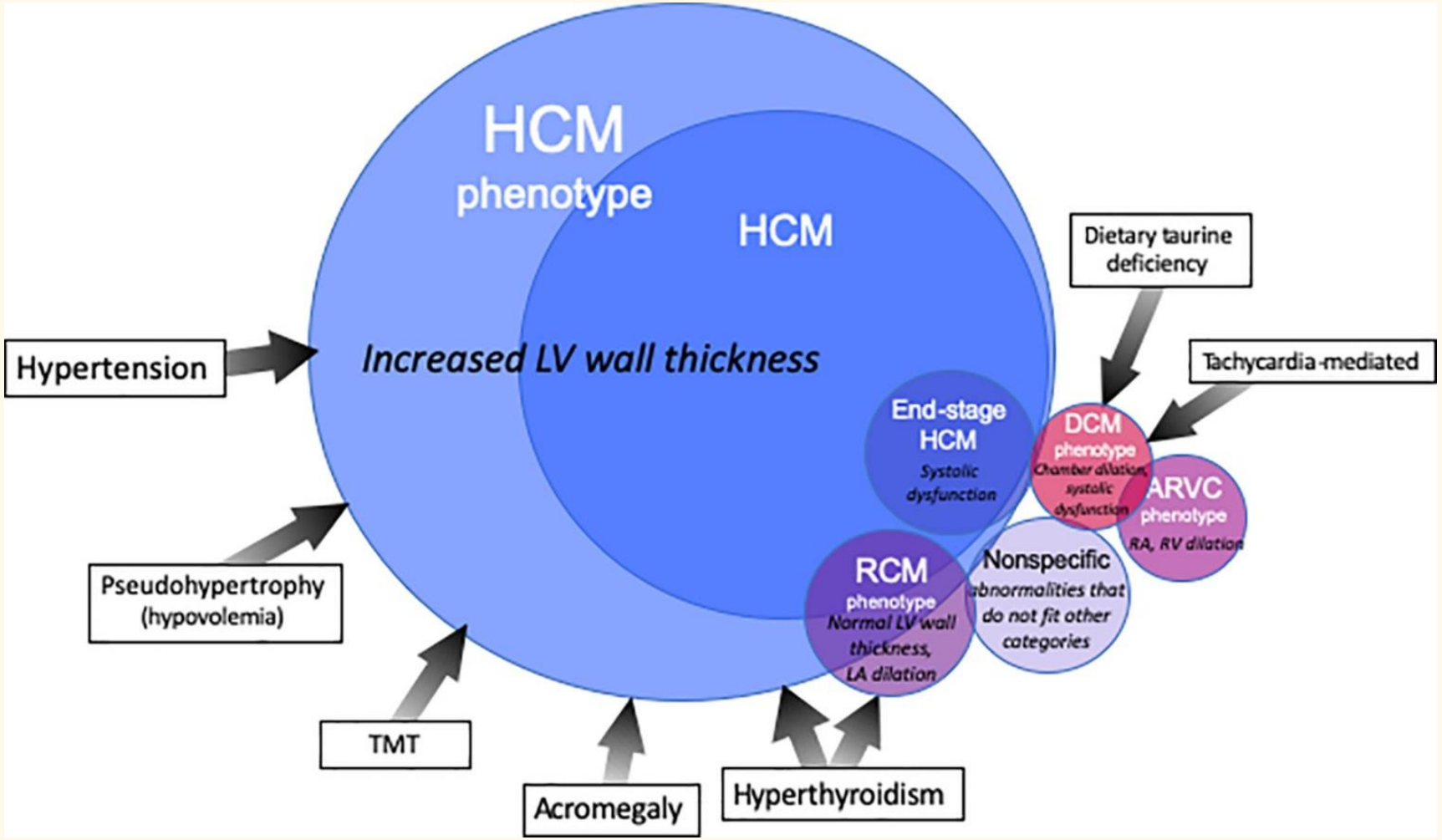
- Echocardiography
- 24-hour Holter monitor

Alternative

- NT-pro BNP
  - >500pmol/l
- 5-minute ECG
  - 1 VPC
- Cardiac troponin I
  - >0.22ng/ml

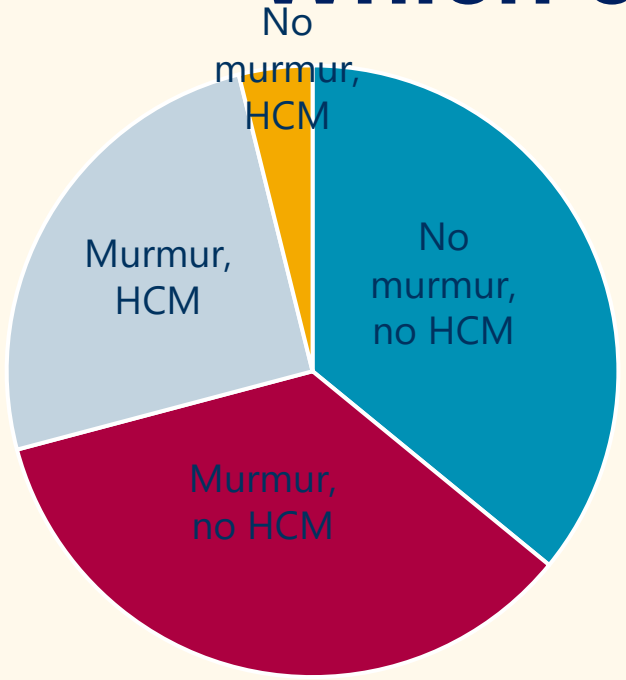
Feline Cardiomyopathy

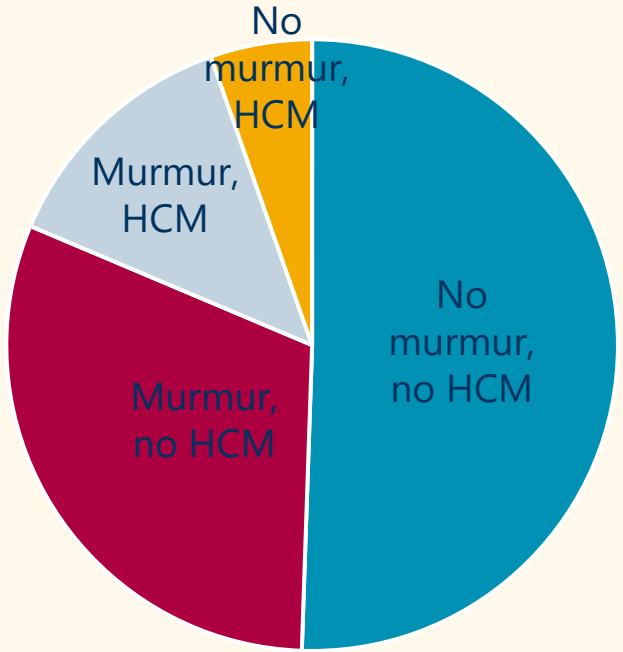
ACVIM consensus statement guidelines for the classification, diagnosis, and management of cardiomyopathies in cats



Luis Fuentes V, Abbott J, Chetboul V, et al. ACVIM consensus statement guidelines for the classification, diagnosis, and management of cardiomyopathies in cats. *J Vet Intern Med*. 2020; 34: 1062–1077. https://doi.org/10.1111/jvim.15745

Which cats should we screen?



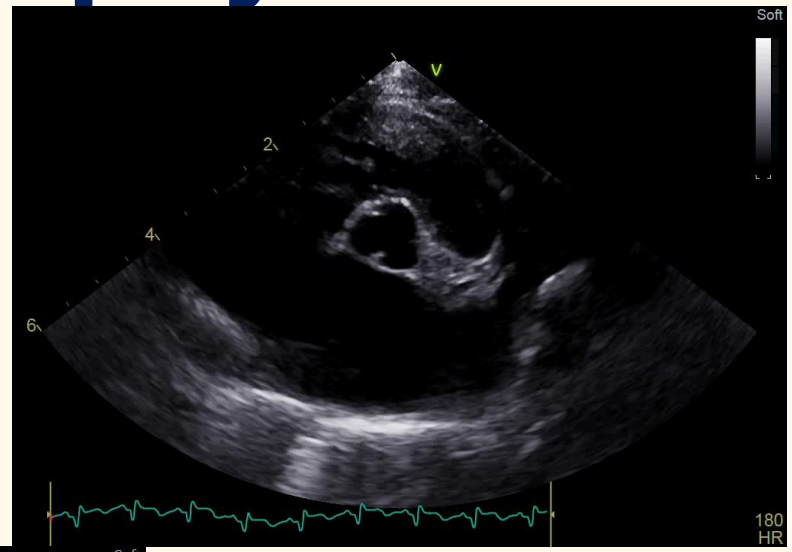


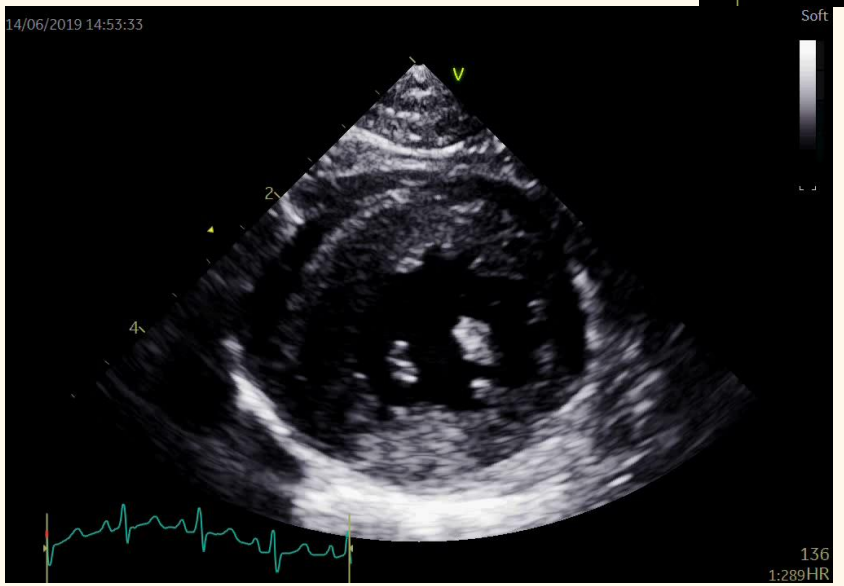
	>9 years	**Cats 3-9 years**
•	Murmur prevalence 59.8%	44.1%
•	HCM prevalence 29.4%	18.6%
•	Sens 86.7%	71.1%
•	Spec 51.4%	62.1%
•	PPV 42.6%	30.1%
•	NPV 90.2%	90.4%

Payne JR, Brodbelt DC, Luis Fuentes V. Cardiomyopathy prevalence in 780 apparently healthy cats in rehoming centres (the CatScan study). J Vet Cardiol. 2015 Dec;17 Suppl 1:S244-57.

Echocardiography

- Gold standard
- POCUS can detect left atrial enlargement (stage B2)





Radiographs

- **VHS <8.1v** cardiomegaly unlikely but doesn't rule out heart disease.
- **"Valentine" heart** on DV/VD suggests cardiac disease BUT 7-12% have normal echo.
- Low sensitivity but high specificity for LA enlargement overall

NT pro BNP

- Mild disease
  - Insensitive
- Moderate or severe disease
  - Good negative predictive value
  - Moderate positive predictive value
- Use to decide if need further testing

Cut-off values recommend by IDEXX using the Feline Cardiopet® proBNP Assay*	
<100pmol/l	Clinically significant cardiomyopathy is unlikely
100-270pmol/l	Clinically significant cardiomyopathy is unlikely but early disease may be present. Consider repeating NT-proBNP in 3–6 months or an echocardiogram.
>270pmol/l	Clinically significant cardiomyopathy is highly likely. Further cardiac work-up including an echocardiogram is recommended.
IDEXX Laboratories Inc., Westbrook (ME)	

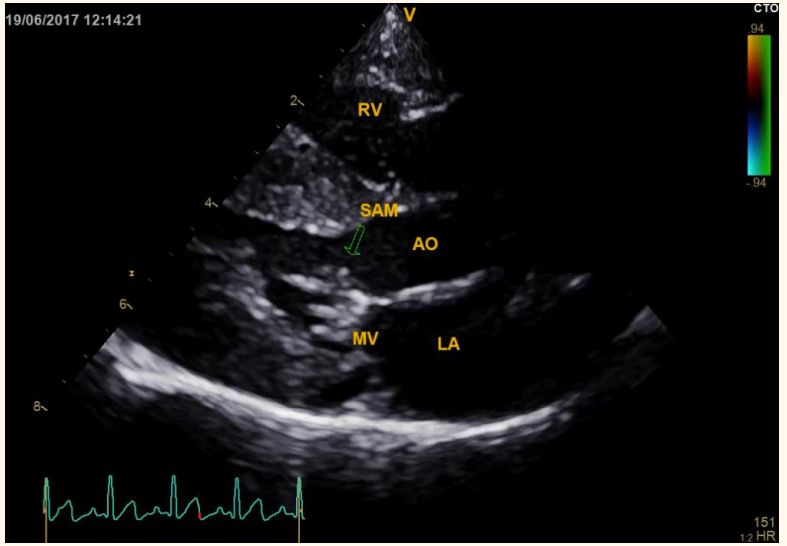
NT-proBNP	Lighter	Equal	Darker
			
Evaluation	Normal	Abnormal	Abnormal
NT-proBNP concentration (pmol/L)	24 (24-31)[a]	162 (100-217)[b]	505 (336-1312)[c]
No of POCT	108	6	25

Normal or mild heart disease likely

Moderate to severe heart disease likely

Cardiac Troponin I

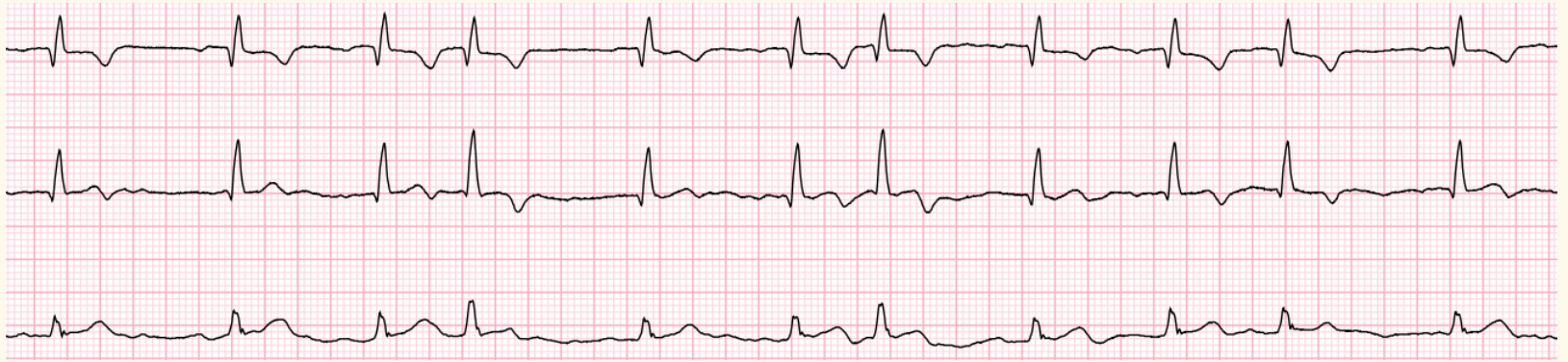
- Cutoff of >0.06 ng/mL
  - Sensitivity 87.8%
  - Specificity 95.4%
- Higher if SAM present
- Use to decide if need further testing



ECG

Arrhythmia very suggestive of cardiomyopathy in cats (only 4/106 cats with a ventricular arrhythmia had normal echo)

"Sensitivity of a 6-lead ECG for detecting LV hypertrophy or LA enlargement is low and ECG is ***not recommended as a screening method*** *for cardiomyopathies in cats"*



Summary for Pre-Clinical HCM

Gold standard

- Echocardiography

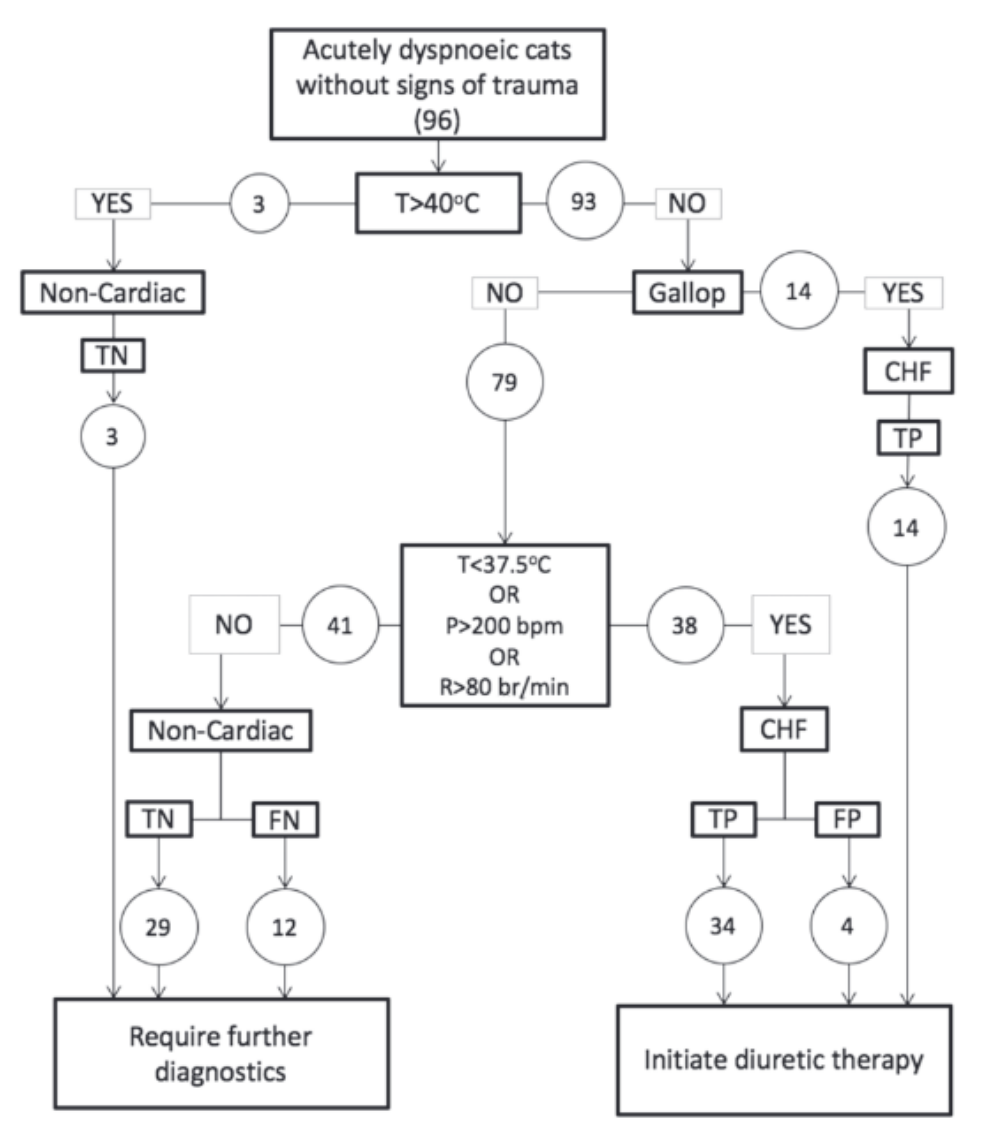
Alternative

- NT proBNP
- Thoracic radiographs
- ECG for arrhythmia

BSAVA
PAPER

Rapid assessment with physical examination in dyspnoeic cats: the RAPID CAT study

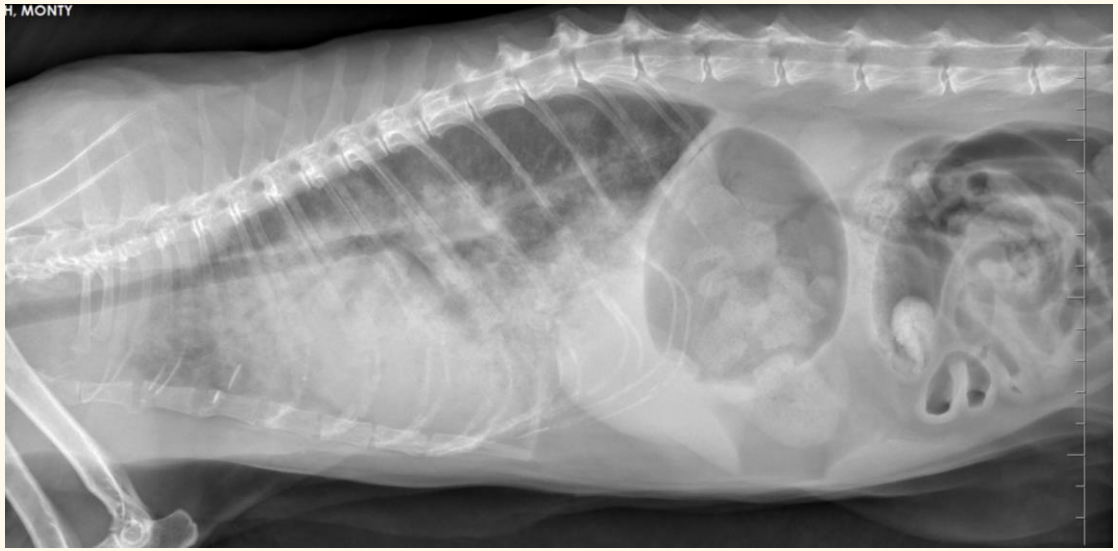
D. Dickson*,1, C. J. L. Little†, J. Harris‡ and M. Rishniw§



Radiographs

- **VHS ≤8.0v** normal

- **VHS >9.3v** highly suggestive of cardiac disease as cause for respiratory signs



J Vet Intern Med 2016;30:536–542

Differentiation of Cardiac from Noncardiac Pleural Effusions in Cats using Second-Generation Quantitative and Point-of-Care NT-proBNP Measurements

M.J. Hezzell, J.E. Rush, K. Humm, E.A. Rozanski, J. Sargent, D.J. Connolly, A. Boswood, and M.A. Oyama

Second generation EDTA plasma

>199pmol/l : Sensitivity 95.2%, specificity 82.4%

POC positive: Sensitivity 95.2% and specificity 87.5%

Second generation pleural effusion

>240pmol/l : Sensitivity 100%, specificity 76.5%

POC positive: Sensitivity 100% and specificity 64.7%

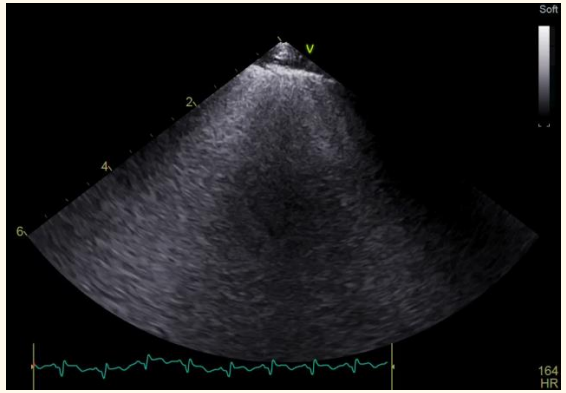
Can use diluted pleural effusion (1:1 NaCl 0.9%)

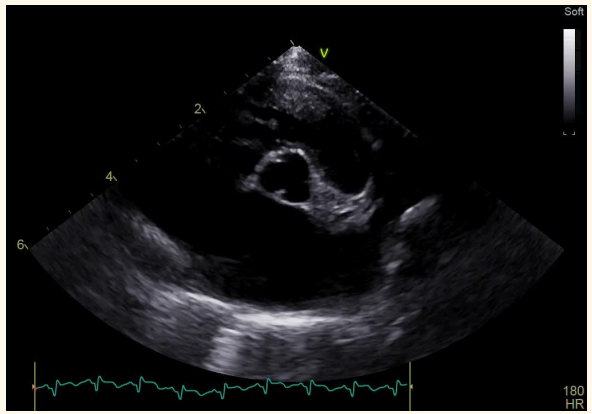
High negative predictive value - rule out test

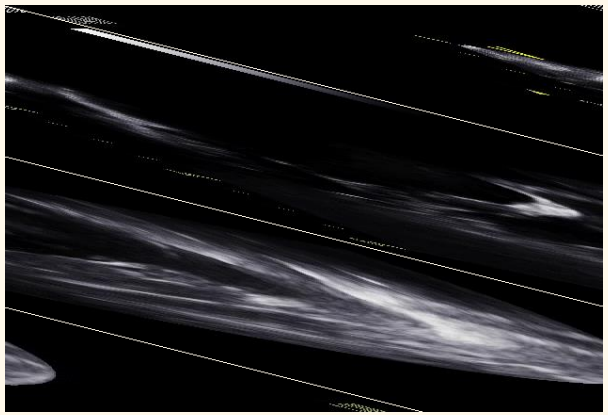
Indiscriminate testing - increase risk of false positive

Evaluation of point-of-care thoracic ultrasound and NT-proBNP for the diagnosis of congestive heart failure in cats with respiratory distress

Jessica L. Ward[1] | Gregory R. Lisciandro[2] | Wendy A. Ware[1] | Austin K. Viall[3] | Brent D. Aona[4] | Kari A. Kurtz[4] | Yamir Reina-Doreste[4] | Teresa C. DeFrancesco[4]







NT-proBNP	Lighter	Equal	Darker
			
Evaluation	Normal	Abnormal	Abnormal
NT-proBNP concentration (pmol/L)	24 (24-31)[a]	162 (100-217)[b]	505 (336-1312)[c]
No of POCT	108	6	25

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>3 B-lines in a site
- Sensitivity 78.8%
- Specificity 83.3%

Subjective LA enlargement
- Sensitivity 97.0%
- Specificity 100%

Pericardial effusion
- Sensitivity 60.6%
- Specificity 100%

RULE IN TEST

Positive blood NT-proBNP
- Sensitivity 93.9%
- Specificity 72.2%

RULE OUT TEST

Cardiac Troponin I

- 0.19-0.24 ng/ml 100% sensitivity for CHF
- 0.66-1.42 ng/ml 100% specificity for CHF

- 0.19-1.42 ng/ml grey area

- Overall poorer performance than NT-proBNP

Summary

- Use diagnostic tests in appropriate patients
- Do not interpret test results in isolation
- Know when is it appropriate to refer

Questions?