CARDIAC EDUCATION group

ABCDs OF CANINE CARDIOMYOPATHY

Canine Cardiac Diagnostic Scheme

Canine cardiomyopathy is a myocardial disease that is characterized by some combination of ventricular dilation, decreased systolic function, or arrhythmia. Cardiomyopathy can be familial or idiopathic or have defined underlying cause(s).

Breeds commonly affected by cardiomyopathy include Boxers, Doberman Pinschers, Great Danes, Irish Wolfhounds, and Scottish Deerhounds.

STAGE A

Dogs that are predisposed to cardiomyopathy (CM) but currently have no clinical evidence of heart disease

Red background: High-priority CEG recommendations

Gray background: Lower-priority CEG recommendations

? Where this icon appears, mouse over it to see additional information.

CEG Diagnostic Recommendations

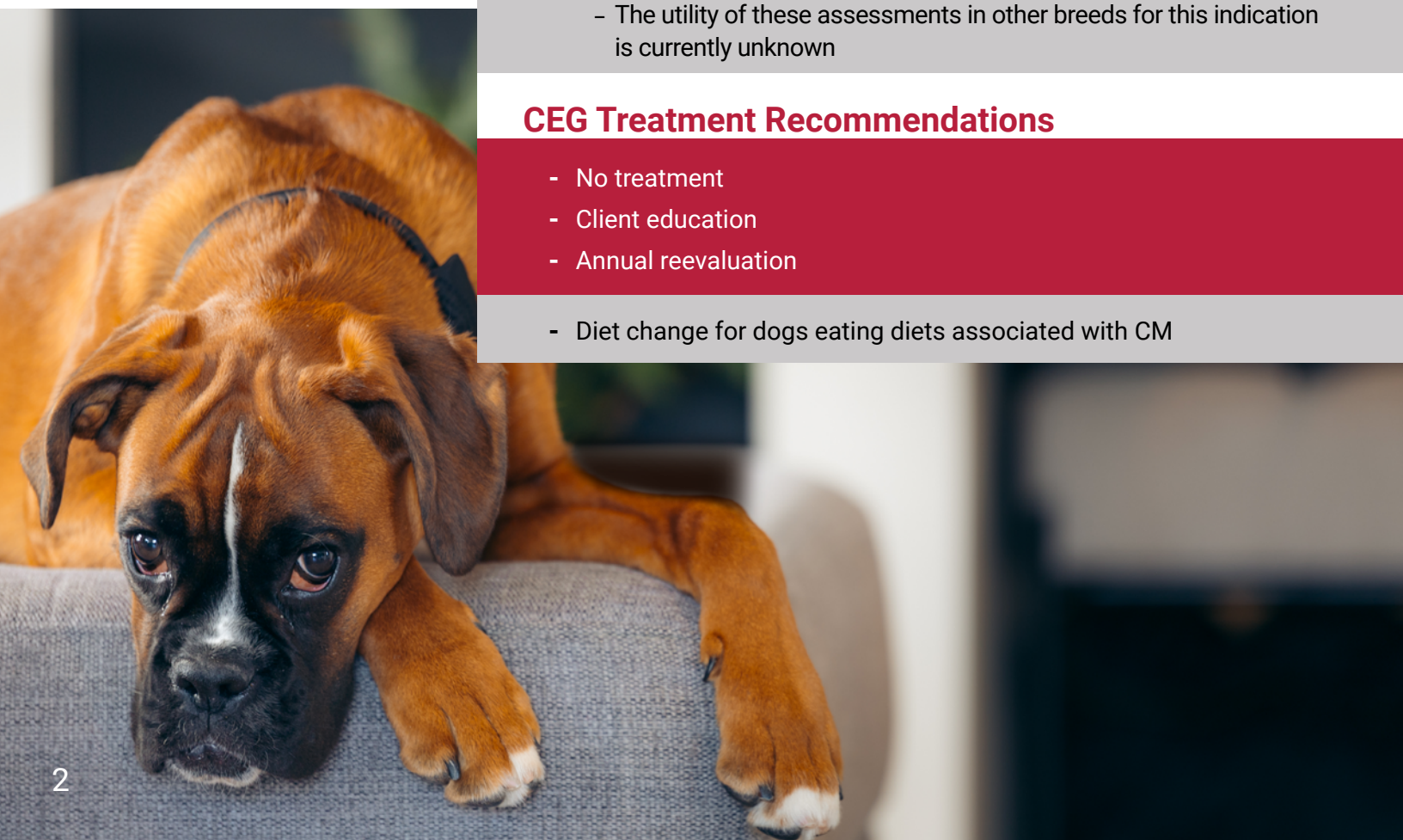
- Patient history[1]
  - Obtain diet history[2]
  - Confirm the absence of exercise intolerance, increased respiratory rate or effort, syncope, collapse, and unintended weight loss
- Yearly auscultation
  - The absence of a heart murmur or arrhythmia does not exclude the possibility of preclinical CM
- Screening echocardiography for predisposed breed or dogs consuming nontraditional diets,[2] typically initiated at 2 to 3 years of age or prior to breeding
- 24-hour ambulatory (Holter) ECG for predisposed breeds

- Patient history
  - Investigate regional origin or travel history[3]
- Genetic tests[4] are available for Boxers, Doberman Pinschers, and Standard Schnauzers
- Cardiac biomarkers (NT-proBNP and cTnI)
  - Elevated concentrations may be used to identify Doberman Pinschers (NT-proBNP >500 pmol/L, cTnI >0.112 ng/mL) that may benefit from further diagnostic evaluation
  - The utility of these assessments in other breeds for this indication is currently unknown

CEG Treatment Recommendations

- No treatment
- Client education
- Annual reevaluation

- Diet change for dogs eating diets associated with CM



Dogs with CM that do not have active or previous clinical signs of CHF or arrhythmia

STAGE B

Defining Stages B1 and B2

Manifestations of Stage B CM include various combinations of ventricular dilation, reduced systolic function, or arrhythmia. Stage B dogs can be clinically divided into Stage B1 or B2 based on risk of CHF or SCD:

- **Stage B1**: Equivocal arrhythmic or dilated CM and no clear indication for treatment based on the examiner's assessment of low risk of CHF and SCD
- **Stage B2**: Treatment is indicated based on the examiner's assessment of increased risk of CHF or SCD

Differentiation of Stages B1 and B2 is challenging and there are currently no unified diagnostic criteria, but differentiation typically depends on a comprehensive echocardiogram and rhythm analysis.

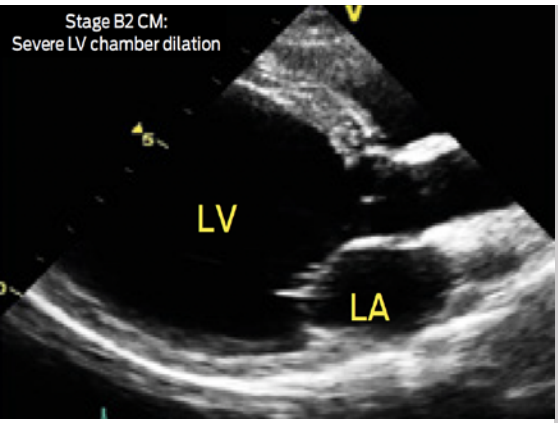
CEG Diagnostic Recommendations: Stages B1 and B2

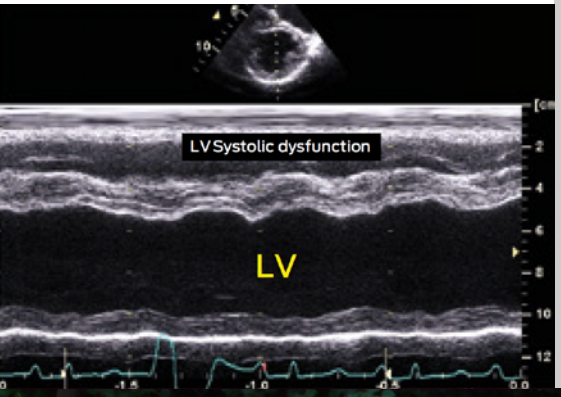
- Patient history[1]
  - Obtain diet history[2]
  - Confirm the absence of exercise intolerance, increased respiratory rate or effort, syncope, collapse, and unintended weight loss[1]
  - Screen history for prior treatment with cardiotoxic agents (e.g., doxorubicin)
  - Investigate regional origin or travel history[3]
- Physical examination[5] with emphasis on:
  - Documentation of unintended reduction in BW, BCS, or MCS
  - Evaluation of respiratory rate and effort
  - Cardiac and pulmonary auscultation
  - Evaluation of peripheral pulse character
  - Jugular examination for distention
  - Abdominal palpation for free fluid or organomegaly
- Echocardiography[6]
  - Echocardiographic findings should be interpreted with caution
  - Potential for overdiagnosis of CM is increased in asymptomatic dogs
  - Multiple methods of assessment of LV systolic function should be used, and a cardiologist should be consulted as needed
  - Concurrent serious systemic diseases, including hypothyroidism or sepsis, or substantial increases or decreases in blood volume, can complicate the diagnosis of CM
- ECG when a cardiac arrhythmia is evident during clinical examination[7]
- 24-hour ambulatory (Holter) ECG[7]

STAGE B

Dogs with CM that do not have active or previous clinical signs of CHF or arrhythmia

CEG Diagnostic Recommendations: Stages B1 and B2 (cont.)





- Confirmation of a diagnosis of Stage B CM requires an echocardiogram and evaluation of cardiac rhythm. If an echocardiogram is not available or declined, other tests (NT-proBNP, cTnI, blood pressure,[8] thoracic radiographs[9]) can be used to encourage compliance for confirmatory testing
- Cardiac biomarkers (NT-proBNP and cTnI)
  - Elevated concentrations may be used to identify Doberman Pinschers (NT-proBNP >500 pmol/L, cTnI >0.112 ng/mL) that may benefit from further diagnostic evaluation
  - The utility of these assessments in other breeds for this indication is currently unknown, but substantially elevated concentrations for the breed can be considered an indication for confirmatory diagnostic testing[6]
  - cTnI is recommended when myocarditis is suspected and in septic patients[3]
- Baseline clinical laboratory tests prior to initiating therapy in Stage B2 patients
- Evaluation of whole blood or plasma taurine concentrations in dogs with suspected diet-associated CM[10]

Cardiac biomarkers and thoracic radiographs can be used to identify dogs at increased risk of having subclinical (Stage B) CM that would benefit from confirmatory testing.

Dogs with CM that do not have active or previous clinical signs of CHF or arrhythmia

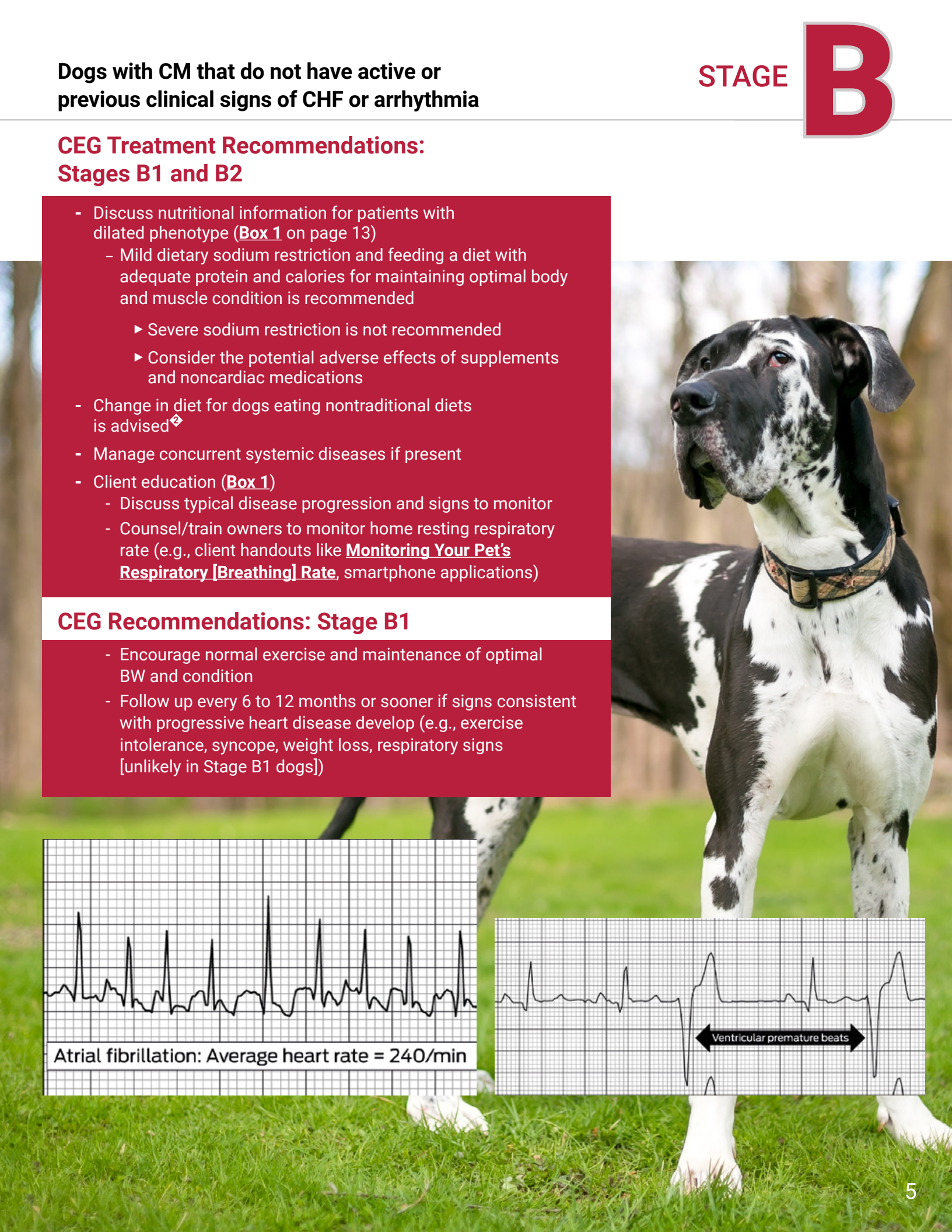
STAGE **B**

CEG Treatment Recommendations: Stages B1 and B2

- Discuss nutritional information for patients with dilated phenotype (**Box 1** on page 13)
  - Mild dietary sodium restriction and feeding a diet with adequate protein and calories for maintaining optimal body and muscle condition is recommended
    - ▸ Severe sodium restriction is not recommended
    - ▸ Consider the potential adverse effects of supplements and noncardiac medications
- Change in diet for dogs eating nontraditional diets is advised[2]
- Manage concurrent systemic diseases if present
- Client education (**Box 1**)
  - Discuss typical disease progression and signs to monitor
  - Counsel/train owners to monitor home resting respiratory rate (e.g., client handouts like **Monitoring Your Pet's Respiratory [Breathing] Rate**, smartphone applications)

CEG Recommendations: Stage B1

- Encourage normal exercise and maintenance of optimal BW and condition
- Follow up every 6 to 12 months or sooner if signs consistent with progressive heart disease develop (e.g., exercise intolerance, syncope, weight loss, respiratory signs [unlikely in Stage B1 dogs])



Atrial fibrillation: Average heart rate = 240/min

STAGE B

Dogs with CM that do not have active or previous clinical signs of CHF or arrhythmia

Management of arrhythmias can be challenging, and consultation with a cardiologist is recommended.

CEG Treatment Recommendations: Stage B2

- Few studies have evaluated the treatment of Stage B2 canine CM
- Treatment of LV chamber dilation and systolic dysfunction
  - Pimobendan (**Box 2** on page 13)
  - Client education (**Box 1**)
  - Home monitoring of resting respiratory rate may help identify development of CHF signs
  - Exercise: Stage B2 patients can exercise as tolerated, avoiding strenuous exercise, especially during periods of high heat or humidity
- Treatment of arrhythmias[11]
  - Sotalol is recommended for treatment of clinically important arrhythmias and complex ventricular arrhythmias[7]; sotalol should be used with caution in dogs with severe systolic dysfunction
  - Diltiazem is recommended for treatment of atrial fibrillation characterized by high heart rates[12]
- Taurine supplementation is recommended in dogs with documented taurine concentration below reference range
- Follow-up
  - Reevaluation every 4 to 8 months or sooner if signs consistent with progressive heart disease develop (e.g., exercise intolerance, syncope, weight loss, increase in home resting or sleeping respiratory rate)
  - More frequent rechecks may be necessary for dogs with severe arrhythmias
  - Follow-up ambulatory (Holter) ECG monitoring may be helpful to assess antiarrhythmic therapy efficacy

- Treatment of LV chamber dilation and systolic dysfunction (**Box 2**)
  - ACEI (e.g., benazepril, enalapril)
  - Spironolactone
- Additional therapies may be useful; consultation with a cardiologist may be helpful

Dogs with past or current clinical signs attributable to CHF or arrhythmia

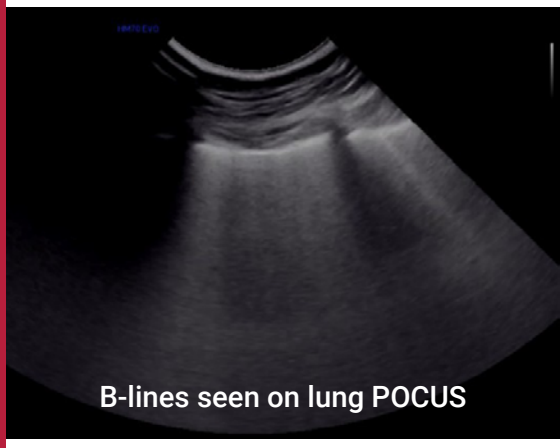
STAGE C

CEG Diagnostic Recommendations

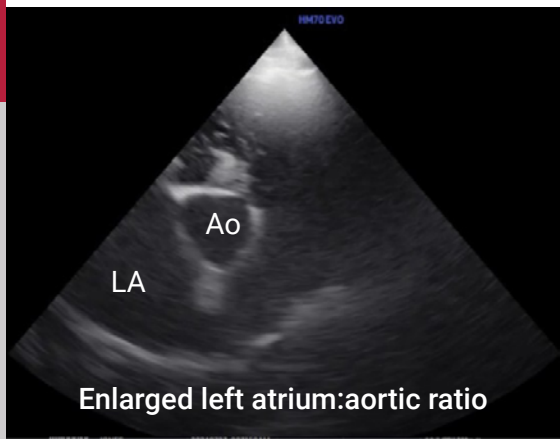
- Patient history[1]
  - Obtain diet history[2]
  - Record resting home respiratory rate (if available)
  - Query exercise tolerance, respiratory effort, syncope, collapse, and unintended weight loss/reduced appetite[1]
- Physical examination[5] with emphasis on:
  - Documentation of unintended reduction in BW, BCS, or MCS
  - Evaluation of respiratory rate and effort
  - Cardiac and pulmonary auscultation
  - Evaluation of peripheral pulse character
  - Jugular examination for distention
  - Abdominal palpation for free fluid or organomegaly
- Thoracic radiographs as soon as they can be safely performed[13]
- Echocardiography for definitive diagnosis of CM (if not previously performed) when available[6]
- POCUS may be used to identify cardiac, pulmonary, and cavitary abnormalities consistent with a diagnosis of CHF and is also recommended prior to therapeutic centesis
- ECG when cardiac arrhythmia or inappropriate heart rate is evident during clinical examination. Ambulatory (Holter) ECG or an event monitor may be useful to evaluate heart rhythm disturbances or syncope[7]
- Baseline clinical laboratory tests are recommended prior to initiating therapy in Stage C patients
- Blood pressure[8]

- Patient history[1]
  - Screen history for prior treatment with cardiotoxic agents (e.g., doxorubicin)
  - Investigate regional origin or travel history[3]
- NT-proBNP evaluation might help discriminate between dogs with respiratory disease and those with CHF

Thoracic point-of-care ultrasound can be helpful to diagnose active congestive heart failure.



B-lines seen on lung POCUS



Enlarged left atrium:aortic ratio

Common clinical signs of Stage C CM include increased resting or sleeping respiratory rate/effort, cough associated with changes in breathing, ascites, exercise intolerance, collapse, syncope, reduced appetite, or unintended weight/muscle loss.

STAGE C

Dogs with past or current clinical signs attributable to CHF or arrhythmia

CEG Treatment Recommendations

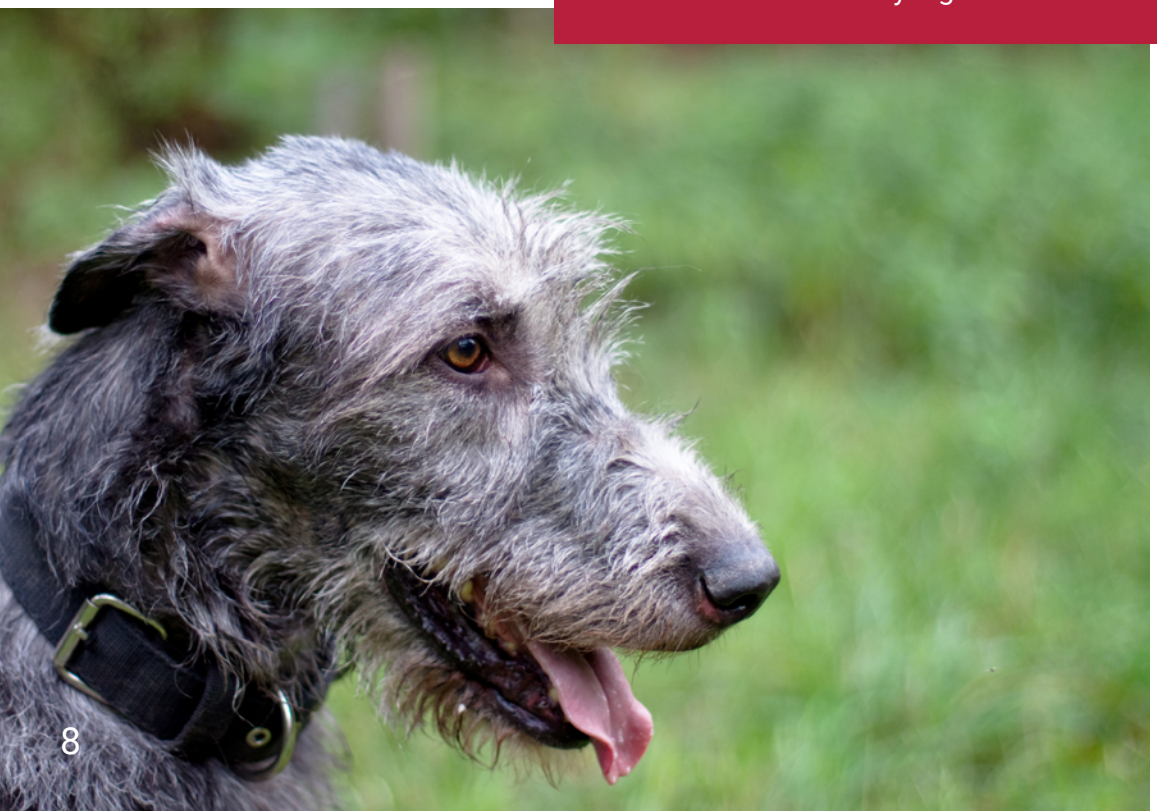
Management of Stage C CM can be challenging, and consultation with a cardiologist may be beneficial.

Initial Treatment of Life-Threatening CHF

- Initial treatment of acute CHF should include injectable furosemide and oxygen supplementation in all patients; butorphanol sedation can be administered if needed (**CEG Formulary**)
- Administer pimobendan in all patients as soon as oral medication can be given
- Life-threatening arrhythmias (e.g., ventricular tachycardia) require immediate lidocaine administration (**CEG Formulary**)
- These patients require 24-hour care and may benefit from specialty referral and additional individualized therapy such as short-term dobutamine therapy
- Initial stabilization of the patient is often necessary before transport is considered
- Consultation with a cardiologist or other specialist might be helpful in severe cases

Treatment of Chronic CHF in Canine Cardiomyopathy

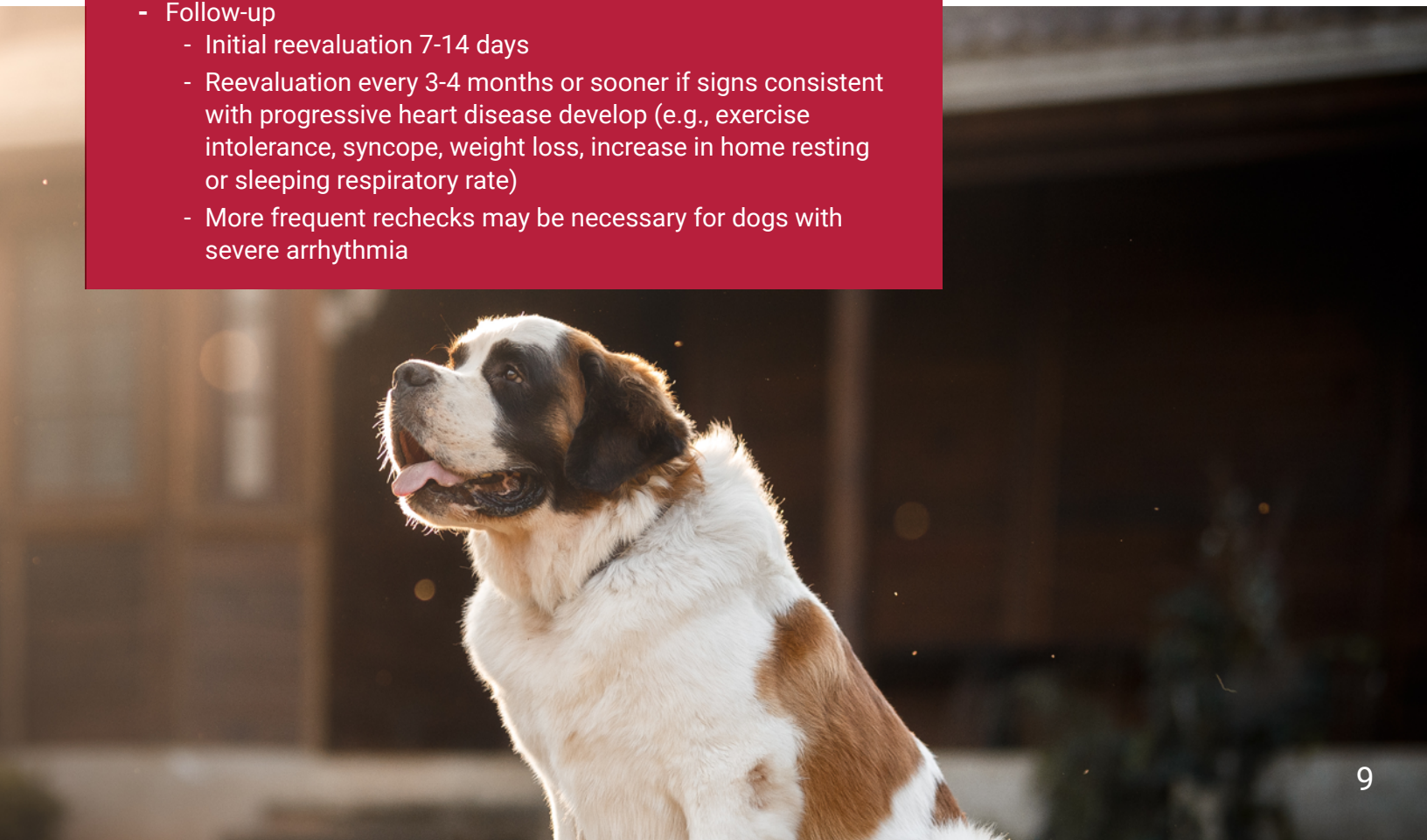
- Standard therapy for CHF includes furosemide, pimobendan, ACEIs, and spironolactone (**CEG Formulary**; **Box 2**)
- Treatment of arrhythmias
  - Sotalol or mexiletine is recommended for treatment of symptomatic and complex ventricular arrhythmias[7] [11]; sotalol should be used with caution in dogs with severe systolic dysfunction or severe CHF
  - Diltiazem is recommended for treatment of atrial fibrillation characterized by high heart rates[12]



CEG Treatment Recommendations (cont.)

- Centesis for large-volume effusions (e.g., ascites, pleural effusion)
  - Centesis should aim to remove as much fluid as possible
- Discuss nutritional information (**Box 1**)
  - Mild to moderate dietary sodium restriction for dogs in CHF
  - Feed a highly palatable diet with adequate protein and calories to maintain optimal muscle condition
  - Avoid high-salt treats
  - Change in diet strongly recommended for dogs eating nontraditional diets associated with CM[2]
- Exercise
  - Should be temporarily limited in dogs with active CHF
  - When pulmonary edema has resolved, gentle exercise is encouraged as tolerated, avoiding prolonged or strenuous activity, especially during periods of high heat or humidity
- Manage concurrent systemic diseases if present
- Client education (**Box 1**)
  - Discuss typical signs of recurrence of heart failure
  - Counsel/train owners to monitor home resting respiratory rate (e.g., **Monitoring Your Pet's Respiratory [Breathing] Rate**, smartphone applications)
- Follow-up
  - Initial reevaluation 7-14 days
  - Reevaluation every 3-4 months or sooner if signs consistent with progressive heart disease develop (e.g., exercise intolerance, syncope, weight loss, increase in home resting or sleeping respiratory rate)
  - More frequent rechecks may be necessary for dogs with severe arrhythmia

Large-volume effusions in the abdomen or thorax should be fully drained to improve patient comfort and stability.



STAGE D

Dogs with end-stage CM and clinical signs of heart failure or arrhythmia refractory to standard therapy

Stage D dogs have persistent clinical signs of CM despite exceeding standard doses of recommended medications.

CEG Diagnostic Recommendations

- Patient history
  - Obtain diet history with emphasis on recent changes in diet and appetite[2]
  - Assess recent resting home respiration rate (if available) and changes in living environment
  - Assess for medication compliance, and recheck all current dosages
  - Assessment of adverse events (e.g., toxicity, medication interactions) related to current medical management and dosages, including noncardiac medications (e.g., thyroxine, NSAIDs, steroids, theophylline, phenylpropanolamine)
- Physical examination with emphasis on:
  - Documentation of unintended reduction in BW, BCS, or MCS
  - Evaluation of respiratory rate and effort
  - Cardiac and pulmonary auscultation
  - Evaluation of peripheral pulse character
  - Jugular examination for distention
  - Abdominal palpation for free fluid or organomegaly
- Careful screening for concurrent systemic disease to identify possible noncardiac causes of current clinical signs[14]
- Thoracic radiographs[13]
- Blood pressure[15]
- ECG when inappropriate heart rate or cardiac arrhythmia is evident during clinical examination
- Clinical lab tests: serum biochemistries, PCV/TS (or CBC), thyroid assessment if appropriate
- POCUS may be used to guide therapeutic decisions and is recommended prior to centesis

- Echocardiography for definitive diagnosis of underlying CM (if not previously done) and screening for complications

Dogs with end-stage CM and clinical signs of heart failure or arrhythmia refractory to standard therapy

STAGE D

Managing Stage D Patients

- Stage D management goals should emphasize patient quality of life and include end-of-life discussions
- Recommendations are typically symptom-specific and may be related to concurrent morbidities as well as clinical signs of CM
- Doses of recommended standard heart failure medications can often be modified
- Additional therapies may be helpful
- Severe sodium restriction can be considered, if tolerated, for chronic therapy
- Some medications may require temporary or permanent discontinuation
- Consultation with a cardiologist may be very helpful and is strongly recommended

Management of Stage D CM can be challenging, and consultation with a cardiologist is recommended.

CEG Treatment Recommendations

- Standard therapy for CHF includes furosemide, pimobendan, ACEIs, and spironolactone (**CEG Formulary**; **Box 2**)
- Treatment of refractory CHF may require escalation of diuretic therapy (increasing furosemide dose, changing to or adding another diuretic)
- Treatment of arrhythmias
  - Sotalol or mexiletine is recommended for treatment of symptomatic and complex ventricular arrhythmias[7,11]; sotalol should be used with caution in dogs with severe systolic dysfunction or severe CHF
  - Diltiazem is recommended for treatment of atrial fibrillation characterized by high heart rates[12]

STAGE D

Dogs with end-stage CM and clinical signs of heart failure or arrhythmia refractory to standard therapy

CEG Treatment Recommendations (cont.)

Management strategies in Stage D should emphasize quality of life.

- Centesis for large-volume effusions (e.g., ascites, pleural effusion)
  - Centesis should aim to remove as much fluid as possible
- Discuss nutritional goals (**Box 1**)
  - Mild to moderate dietary sodium restriction for dogs in CHF
  - Feed a highly palatable diet with adequate protein and calories to maintain optimal muscle condition
  - Homemade diets can be considered to ensure adequate calorie intake
  - Avoid high-salt treats
  - Change in diet for dogs eating diets associated with CM
- Appetite stimulants may be useful to support oral intake
- Exercise
  - Should be temporarily limited in dogs with active CHF
  - When pulmonary edema has resolved, gentle exercise is encouraged as tolerated, avoiding prolonged or strenuous activity, especially during periods of high heat or humidity
- Manage concurrent systemic diseases that are contributing to poor quality of life
- Client education (**Box 1**)
  - Discuss typical disease signs of recurrence of heart failure
  - Counsel/train owners to monitor home resting respiratory rate (e.g., **Monitoring Your Pet's Respiratory [Breathing] Rate**, smartphone applications)
- Follow-up
  - More frequent rechecks may be necessary for dogs with severe arrhythmias
  - Reevaluation as needed if signs consistent with progression or recurrence of heart failure or poor quality of life (e.g., exercise intolerance, syncope, hyporexia, anorexia, weight loss, increase in home resting or sleeping respiratory rate)
  - Reevaluations are typically more frequent in Stage D

Nutrition-related goals (beyond replacing diets associated with CM) must prioritize adequate calorie consumption over optimal sodium content. It is more important that the patient eats, rather than what they eat.

Box 1

Clinical Resources

CEG Client Handout: Arrhythmogenic Ventricular Cardiomyopathy (ARVC) in Dogs
CEG Client Handout: Dilated Cardiomyopathy (DCM) in Dogs
CEG Circulations: Nutritional Management of Heart Disease (part 1)
CEG Circulations: Implementing an Optimal Nutrition Plan for Your Cardiovascular Patient (part 2)
CEG Circulations: Reading ECGs
CEG Circulations: Tips for Diagnosing Heart Failure; Using Resting Home Respiration Rate
CEG Client Handout: Monitoring Your Pet's Respiratory (Breathing) Rate
CEG Formulary: Cardiac Medications for Dogs
CEG Practice Pointers: Evaluating Radiographic Heart Size Using VHS and VLAS
European Society of Veterinary Cardiology Screening Guidelines for DCM in Dobermans
WSAVA Global Nutrition Committee Tool Kit

Box 2

Medical Therapy for CM

- **ACEI.** ACEIs have been shown to delay the onset of CHF in Dobermans with Stage B2 preclinical dilated CM.
- **Pimobendan.** Pimobendan has been proven to delay the onset of CHF and SCD in Dobermans and Irish Wolfhounds with Stage B2 preclinical dilated CM. Pimobendan may also be useful in other breeds.
- **Spironolactone.** The addition of spironolactone to an ACEI offers more comprehensive inhibition of the RAAS and can be considered cardioprotective, but there is no proof of efficacy in preclinical Stage B2 CM. If RAAS-inhibiting medications are used, potassium concentration should be monitored with some frequency to identify potential hyperkalemia.
- **Standard therapy.** Furosemide and pimobendan are typically the first cardiac medications to be initiated; an ACEI and spironolactone can be added to chronic therapy once the dog is stabilized.

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Endnotes

1. CM may be suspected in a dog with a history of syncope, collapse, exercise intolerance, or unintended weight loss (reduction in BCS or MCS) or when a murmur, gallop, or tachyarrhythmia is detected on physical examination. However, many dogs with preclinical (Stage B1 and B2) CM will have a normal history and physical examination.
2. Diet-associated CM can mimic or complicate the diagnosis of idiopathic dilated CM. Dogs eating nontraditional diets associated with development of CM may benefit from a diet change and/or additional screening. Breeds considered at increased risk for diet-associated CM include Golden Retrievers, Newfoundland dogs, American Cocker Spaniels, Irish Wolfhounds, Saint Bernards, and English Setters. Higher-risk diets include those that do not meet the World Small Animal Veterinary Association recommendations (**Box 1**).
3. Dogs originating from or traveling to specific regions may have an increased risk of exposure to infectious agents that can cause myocarditis (e.g., Chagas disease, tick-borne diseases).
4. Genetic tests do not replace the need for phenotypic screening such as echocardiographic and Holter screening. Genetic testing may be a higher priority in dogs used for breeding.
5. Abnormal physical examination findings indicate that further evaluation is warranted but are not diagnostic for CM. Conversely, some dogs with preclinical CM have a normal physical examination.
6. Echocardiography is used to confirm CM by identifying cardiac chamber dilation and/or reduced systolic function.
7. Arrhythmias can cause or contribute to a CM phenotype. Evaluation of cardiac rhythm is important to diagnose concurrent arrhythmias and CM manifesting only as heart rhythm disturbance (arrhythmogenic cardiomyopathy). Optimal evaluation of cardiac rhythm is best achieved with a 24-hour ambulatory (Holter) ECG but a 3-5 min resting ECG is valuable if a Holter is not available or declined.
8. Blood pressure assessment is used to document normal blood pressure and rule out systemic hypertension.
9. Thoracic radiographs serve as a baseline for future comparison if signs consistent with CHF develop. In addition, when an echocardiogram is not available, radiographic cardiomegaly, in particular a VHS >11.5 identifies many dogs at high risk of heart disease and can be used to encourage clients to pursue an echocardiogram or be used to track progressive cardiomegaly. A normal VHS does not rule out cardiac disease (**see Evaluating Radiographic Heart Size Using VHS and VLAS**).
10. Decreased taurine concentrations may be associated with a dilated CM phenotype and respond to supplementation, but diet-associated CM cannot be ruled out in dogs based on a normal taurine concentration.
11. Typical arrhythmias severe enough to warrant treatment include atrial fibrillation and complex ventricular arrhythmias (e.g., frequent single, pairs, or triplets of ventricular premature complexes; ventricular bigeminy; runs of ventricular tachycardia; see **Reading ECGs**).
12. Echocardiographic evaluation should be undertaken prior to initiation of treatment of atrial fibrillation. Addition of digoxin to diltiazem therapy may improve heart rate control. Relative contraindications for digoxin therapy include impaired renal function, preexisting ventricular ectopy, or conduction disease of the sinus node or atrioventricular node (AV block).
13. Thoracic radiographs may be too stressful to be completed in severely dyspneic patients prior to initiation of stabilization treatment. Thoracic POCUS may be useful to document lung artifacts suggestive of pulmonary edema (B-lines) and cavitary effusions in stressed patients.
14. The order of diagnostic tests should be tailored to the patient's current clinical signs.
15. Blood pressure is strongly recommended in dogs with signs suggestive of hypotension related to poor cardiac output (e.g., azotemia, exercise intolerance).

Abbreviations

ACEI, angiotensin-converting enzyme inhibitor; **BCS**, body condition score; **BW**, body weight; **CBC**, complete blood count; **CEG**, Cardiac Education Group; **CHF**, congestive heart failure; **CM**, cardiomyopathy; **cTnI**, cardiac troponin I; **ECG**, electrocardiogram; **LA**, left atrium; **LV**, left ventricle; **MCS**, muscle condition score; **NSAID**, nonsteroidal anti-inflammatory drug; **NT-proBNP**, N-terminal pro–B-type natriuretic peptide; **PCV/TS**, packed cell volume/total solids; **POCUS**, point-of-care ultrasound; **RAAS**, renin-angiotensin-aldosterone system; **SCD**, sudden cardiac death; **VHS**, vertebral heart score.

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