

CANINE CARDIAC DIAGNOSTIC SCHEME ABCDs OF CANINE CARDIOMYOPATHY

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Canine cardiomyopathy is a myocardial disease that is characterized by some combination of ventricular dilation, decreased systolic function or arrhythmia.

Cardiomyopathy can be familial, idiopathic or have defined underlying cause(s).



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CANINE CARDIOMYOPATHY

STAGE A

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

CEG DIAGNOSTIC RECOMMENDATIONS: STAGE A

- Patient history¹
 - Obtain diet history²
 - Confirm the <u>absence</u> of exercise intolerance, increased respiratory rate or effort, syncope, collapse and unintended weight loss
 - Investigate regional origin or travel history³
- Yearly auscultation⁴
- Screening echocardiography for predisposed breed⁵ or dogs consuming nontraditional diets²
- 24-hour ambulatory (Holter) ECG for predisposed breeds⁵
- Genetic tests⁶ are available for Doberman pinschers, Boxers and Standard Schnauzers
- Cardiac biomarkers (NT-proBNP and cardiac troponin-I)
 - Elevated concentrations may be used to identify Doberman pinschers (NT-proBNP > 500 pmol/l, cTnl >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: STAGE A

- No treatment
- Client education
- Diet change for dogs eating diets associated with CM
- Annual reevaluation

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 CM may be suspected in a dog with a history of syncope, collapse, exercise intolerance or unintended weight loss (reduction in body condition score or muscle condition score), 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.

 Diet-associated CM can mimic or complicate the diagnosis of idiopathic dilated CM. Dogs eating non-traditional diets associated with development of CM may benefit from a diet change and/or additional screening. Breeds considered at increased risk

Abbreviations: CM-cardiomyopathy, CHF-congestive heart failure, SCD-sudden cardiac death, ECG-electrocardiogram

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: WSAVA Global Nutrition Committee Tool Kit and WSAVA Global Nutrition Committee: Guidelines on Selecting Pet Food

- 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 and tick-borne diseases).
- The absence of a heart murmur or arrhythmia does not exclude the possibility of preclinical CM.
- Breeds commonly affected include Doberman pinschers, boxers, Great Danes, Irish wolfhounds and Scottish deerhounds Typically, screening is initiated at 2-3 years of age or prior to breeding.
- 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.

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

References: Journal of Veterinary Cardiology Guidelines for Screening Dobermans

Lower priority diagnostic tests can be used to identify dogs at increased risk of having preclinical (Stage B) CM that would benefit from confirmatory testing.



CANINE CARDIOMYOPATHY

STAGES B1 AND B2

Dogs with CM that do not have active or previous clinical signs of congestive heart failure (CHF) or clinically important arrhythmias

- Manifestations of Stage B CM include various combinations of ventricular dilation, reduced systolic function or arrhythmia
- Stage B dogs can be clinically divided into Stages B1 or B2 based on risk of CHF or sudden cardiac death (SCD):
 - Stage B1: Equivocal 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

CEG DIAGNOSTIC RECOMMENDATIONS: STAGES B1 and B2

Patient history¹

- Obtain diet history²
- Confirm the <u>absence</u> of exercise intolerance, increased respiratory rate or effort, syncope, collapse and unintended weight loss¹
- Screen history for prior treatment with cardiotoxic agents (e.g., doxorubicin)
- Investigate regional origin or travel history³
- Physical examination⁷ with emphasis on:
 - Documentation of unintended reduction in body weight, body condition score or muscle condition score
 - Evaluation of respiratory rate and effort
 - Cardiac and pulmonary auscultation
 - Evaluation of peripheral pulse character
 - Jugular examination for distension
 - Abdominal palpation for free fluid or organomegaly
- Echocardiography⁸
 - 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, 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^{9, 10}
- 24-hour ambulatory (Holter) ECG^{9, 10}

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 Abnormal physical examination findings
 E indicate that further evaluation is warranted but are not diagnostic for CM. Conversely, some dogs with preclinical CM have a normal physical examination.

 Echocardiography is used to confirm CM by identifying cardiac chamber dilation and/or reduced systolic function. Abbreviations: CM-cardiomyopathy, CHF-congestive heart failure, SCD-sudden cardiac death, ECG-electrocardiogram, LV-left ventricle, LA-left atrium

 Evaluation of cardiac rhythm is important to diagnose concurrent arrhythmias and CM manifesting only as heart rhythm disturbance (arrhythmogenic 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.

10. Arrhythmias can cause or contribute to a CM phenotype.





CANINE CARDIOMYOPATHY

STAGES B1 AND B2

Dogs with CM that do not have active or previous clinical signs of congestive heart failure (CHF) or clinically important arrhythmias

CEG DIAGNOSTIC RECOMMENDATIONS: STAGES B1 and B2

- 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, cTnl, thoracic radiographs) can be used to encourage compliance for confirmatory testing
 - Blood pressure¹¹
 - Thoracic radiographs¹²
- Cardiac biomarkers (NT-proBNP and cardiac troponin-I)
 - Elevated concentrations may be used to identify Doberman pinschers (NT-proBNP > 500 pmol/l, cTnl >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 testing⁸
 - Cardiac troponin is recommended when myocarditis is suspected and in septic patients³
- Clinical laboratory tests: serum biochemistries, PCV/TS (or CBC), urinalysis (prior to initiating any therapy in B2 patients)
- Evaluation of whole blood or plasma taurine concentrations in dogs with suspected diet-associated CM¹³

Red text: High priority Black text: Lower priority

 Blood pressure assessment is used to document normal blood pressure and rule out systemic hypertension. Abbreviations: CM-cardiomyopathy, CHF-congestive heart failure, SCD-sudden cardiac death, ECG-electrocardiogram, NT-proBNP, cTnI, PCV/TS, CBC

12. Thoracic radiographs serve as 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. Evaluating Heart Size on Radiograph. 13. Decreased taurine concentrations may be associated with a dilated CM phenotype and respond to supplementation but dietassociated CM cannot be ruled out in dogs based on a normal taurine concentration.

Stage B - Treatment

STAGE



MY PET'S **HEART2HEART**

Click icon below to download the Heart2Heart mobile app for home respiratory rate monitoring





CANINE CARDIOMYOPATHY

STAGES BI AND B2 - TREATMENT

Dogs with CM that do not have active or previous clinical signs of congestive heart failure (CHF) or clinically important arrhythmias

CEG DIAGNOSTIC RECOMMENDATIONS: STAGES B1 and B2

- Discuss nutritional information¹⁴
 - 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 non-cardiac medications
 - Change in diet for dogs eating non-traditional diets is advised²
- Manage concurrent systemic diseases if present
- Client education:
 - Discuss typical disease progression and signs to monitor¹⁵
 - Counsel/train owners to monitor home resting respiratory rate (client handouts, smart phone applications, etc.)¹⁵

CEG TREATMENT RECOMMENDATIONS: STAGE B1

- No treatment
- Encourage normal exercise and maintenance of optimal body weight and condition
- Follow-up g 6-12 months or sooner if signs consistent with progressive heart disease develop, e.g., exercise intolerance, syncope, weight loss or respiratory signs (unlikely in Stage B1 dogs)

Red text: High priority Black text: Lower priority Abbreviations: CM-cardiomyopathy, CHF-congestive heart failure, SCD-sudden cardiac death, ECG-electrocardiogram

14. Implementing an Optimal Nutrition Plan for Your Cardiovascular Patient and Nutritional Management of Heart Disease. 15. Monitoring Your Pet's Respiratory (Breathing) Rate and Tips for Diagnosing Heart Failure; Using Resting Home **Respiration Rate**

Stage B - Treatment

STAGE

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





CANINE CARDIOMYOPATHY

STAGES BI AND B2 - TREATMENT

Dogs with CM that do not have active or previous clinical signs of congestive heart failure (CHF) or clinically important arrhythmias

CEG TREATMENT RECOMMENDATIONS: STAGE B2

- Few studies have evaluated the treatment of Stage B2 canine CM
- Treatment of left ventricular chamber dilation and systolic dysfunction
 Pimobendan¹⁶
 - Angiotensin converting enzyme inhibitor (ACEI), e.g., benazepril, enalapril¹⁷
 - Spironolactone¹⁸
- Treatment of arrhythmias¹⁹
 - Sotalol is recommended for treatment of clinically important arrhythmias and complex ventricular arrhythmias^{9,10}; sotalol should be used with caution in dogs with severe systolic dysfunction
 - Diltiazem is recommended for treatment of atrial fibrillation characterized by high heart rates²⁰
- Taurine supplementation is recommended in dogs with documented taurine concentration below reference range
- Additional therapies may be useful, consultation with a cardiologist may be helpful
- Client education¹⁵
 - Home monitoring of resting respiratory rate may help identify development of congestive heart failure signs
 - Exercise: Stage B2 patients can exercise as tolerated, avoiding strenuous exercise, especially during periods of high heat or humidity
- Follow-up
 - Re-evaluation q 4-8 months or sooner if signs consistent with progressive heart disease develop, e.g., exercise intolerance, syncope, weight loss or 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

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- 16. 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.
- 17. ACEI have been shown to delay the onset of congestive heart failure in Dobermans with Stage B2 preclinical dilated CM.
- The addition of spironolactone to an ACEI offers more comprehensive inhibition of the renin-angiotensin-aldosterone

Abbreviations: CM-cardiomyopathy, CHF-congestive heart failure, SCD-sudden cardiac death, ECG-electrocardiogram

system (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.

19. 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; and/ or runs of ventricular tachycardia). <u>CEG</u> <u>Recommendations: Reading ECG.</u>

20. 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, pre-existing ventricular ectopy or conduction disease of the sinus node or atrioventricular node (AV block).

Common clinical signs of CHF 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.



Thoracic point-of-care ultrasound (POCUS) may be useful to document pulmonary infiltrates in pulmonary edema cases.

CANINE CARDIOMYOPATHY

STAGE C

Dogs with past or current clinical signs of CHF with or without arrhythmias

CEG DIAGNOSTIC RECOMMENDATIONS: STAGE C

- Patient history¹
 - Obtain diet history²
 - Record resting home respiration rate (if available)
 - Query exercise tolerance, respiratory effort, syncope, collapse, and unintended weight loss/appetite¹
 - Screen history for prior treatment with cardiotoxic agents, e.g., doxorubicin
 - Investigate regional origin or travel history³
- Physical examination⁷ with emphasis on:
 - Documentation of unintended reduction in body weight, body condition score or muscle condition score
 - Evaluation of respiratory rate and effort
 - Cardiac and pulmonary auscultation
 - Evaluation of peripheral pulse character
 - Jugular examination for distension
 - Abdominal palpation for free fluid or organomegaly
- Thoracic radiographs as soon as they can be safely performed²¹
- Echocardiography for definitive diagnosis of CM (if not previously performed) when available⁸
- Point of care ultrasound (POCUS) may be used to identify cardiac, pulmonary and cavitary abnormalities consistent with a diagnosis of CHF and is recommended prior to therapeutic centesis
- ECG when cardiac arrhythmia or inappropriate heart rate is evident during clinical examination^{9, 10}
- Clinical lab tests: serum biochemistries, PCV/TS (or CBC) and urinalysis to establish baseline values prior to institution of any therapy
- Blood pressure¹¹
- NT-proBNP evaluation might help discriminate between dogs with respiratory disease from those with CHF
- Ambulatory (Holter) ECG or an event monitor may be useful to evaluate heart rhythm disturbances or syncope^{9,10}

Red text:High priorityBlack text:Lower priority

Abbreviations: CM-cardiomyopathy, CHF-congestive heart failure, SCD-sudden cardiac death, ECG-electrocardiogram, POCUS and NT-proBNP

21. Thoracic radiographs may be too stressful to be completed in severely dyspneic patients prior to initiation of stabilization treatment. Thoracic point-of-care ultrasound may be useful to document pulmonary infiltrates and cavitary effusions in stressed patient

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





CANINE CARDIOMYOPATHY

STAGE C

Dogs with past or current clinical signs of CHF with or without arrhythmias

CEG TREATMENT RECOMMENDATIONS: STAGE C

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 - <u>Canine Formulary</u>
- Administer pimobendan in all patients as soon as oral medication can be given
- Life-threatening arrhythmias (e.g., ventricular tachycardia) require immediate lidocaine administration - <u>Canine Formulary</u>
- 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 therapy²² for CHF includes furosemide, pimobendan, angiotensin converting enzyme inhibitor and spironolactone -<u>Canine Formulary</u>
- Treatment of arrhythmias
 - Sotalol or mexiletine are recommended for treatment of symptomatic and complex ventricular arrhythmias^{9, 10, 19}; sotalol should be used with caution in dogs with severe systolic dysfunction or severe congestive heart failure
 - Diltiazem is recommended for treatment of atrial fibrillation characterized by high heart rates²⁰

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Abbreviations: CM-cardiomyopathy, CHF-congestive heart failure, SCD-sudden cardiac death, ECG-electrocardiogram

22. Furosemide and pimobendan are typically the first cardiac medications to be initiated; an angiotensin-converting enzyme inhibitor and spironolactone can be added to chronic therapy once the dog is stabilized.

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



CANINE CARDIOMYOPATHY

STAGE C

Dogs with past or current clinical signs of CHF with or without arrhythmias

CEG TREATMENT RECOMMENDATIONS: STAGE C

- Centesis for large volume effusions (e.g., ascites)²³
- Discuss nutritional information¹⁴
 - Mild-moderate dietary sodium restriction and feeding of a highly palatable diet with adequate protein and calories for maintaining optimal muscle condition is recommended
 - Avoid high-salt treats
 - Change in diet strongly recommended for dogs eating nontraditional diets associated with CM²
- 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:
 - Discuss typical signs of recurrence of heart failure¹⁵
 - Counsel/train owners to monitor home resting respiratory rate¹⁵
- Follow-up
 - Initial re-evaluation 7-14 days
 - Reevaluation q 3-4 months or sooner if signs consistent with progressive heart disease develop, e.g., exercise intolerance, syncope, weight loss or increase in home resting or sleeping respiratory rate
 - More frequent rechecks may be necessary for dogs with severe arrhythmias

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23. Abdominocentesis is necessary for large volume ascites and should aim to remove as much fluid as possible.

Persistent clinical signs of CM and CHF despite use of standard doses of recommended medications.



CANINE CARDIOMYOPATHY

STAGE D

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

CEG DIAGNOSTIC RECOMMENDATIONS: STAGE D

- Patient history¹
 - Obtain diet history with emphasis on recent changes in diet and appetite²
 - 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 and medication interactions) related to current medical management and dosages, including non cardiac medications, e.g., thyroxine, NSAIDs, steroids, theophylline, phenylpropanolamine
 - Investigate regional origin or travel history³
- Physical examination⁷ with emphasis on:
 - Documentation of unintended reduction in body weight, body condition score or muscle condition score
 - Evaluation of respiratory rate and effort
 - Cardiac and pulmonary auscultation
 - Evaluation of peripheral pulse character
 - Jugular examination for distension
 - Abdominal palpation for free fluid or organomegaly
- Careful screening for concurrent systemic disease to identify possible non-cardiac causes of current clinical signs²⁴
- Thoracic radiographs²¹
- Blood pressure²⁵
- 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
- Point of care ultrasound (POCUS) may be used to identify cardiac, pulmonary and cavitary abnormalities consistent with a diagnosis of CHF and is recommended prior to therapeutic centesis
- Echocardiography for definitive diagnosis of underlying CM (if not previously done) and screening for complications

Red text:High priorityBlack text:Lower priority

Abbreviations: CM-cardiomyopathy, CHF-congestive heart failure, SCD-sudden cardiac death, ECG-electrocardiogram

24. The order of diagnostic tests should be tailored to the patient's current clinical signs 25. Blood pressure is strongly recommended in dogs with signs suggestive of hypotension related to poor cardiac output, e.g., azotemia, exercise intolerance.



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



Nutrition-related goals (beyond replacing diets associated with CM) must prioritize adequate calorie consumption over optimal sodium content and other nutritional goals. **"It is more important that they eat, than** what they eat."

CANINE CARDIOMYOPATHY

STAGE D

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

- 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 heart failure
- Doses of recommended standard heart failure medications can often be modified - <u>Canine Formulary</u>
- Additional therapies may be helpful
- Some medications may require temporary or permanent discontinuation
- Consultation with a cardiologist may be very helpful and is strongly recommended

CEG DIAGNOSTIC RECOMMENDATIONS: STAGE D

- Standard therapy²² for CHF includes furosemide, pimobendan, angiotensin-converting enzyme inhibitor and spironolactone -<u>Canine Formulary</u>
- Treatment of refractory CHF may require escalation of diuretic therapy (increasing furosemide dose and/or adding another diuretic)
- Treatment of arrhythmias
 - Sotalol or mexiletine are recommended for treatment of symptomatic and complex ventricular arrhythmias^{9, 10, 19}; sotalol should be used with caution in dogs with severe systolic dysfunction or severe congestive heart failure
 - Diltiazem is recommended for treatment of atrial fibrillation characterized by high heart rates²⁰
- Centesis for large volume effusions (e.g., ascites)²³
- Discuss nutritional goals¹⁴
 - Mild-moderate dietary sodium restriction and feeding of a highly palatable diet with adequate protein and calories for maintaining optimal muscle condition is recommended
 - Homemade diets can be considered to ensure adequate calorie intake
 - Avoid high-salt treats
 - Change in diet for dogs eating diets associated with CM2
- Appetite stimulants may be useful to support oral intake
- Severe sodium restriction can be considered, if tolerated, for chronic therapy

Red text:High priorityBlack text:Lower priority

Abbreviations: CM-cardiomyopathy, CHF-congestive heart failure, SCD-sudden cardiac death, ECG-electrocardiogram

Management strategies in Stage D should emphasize quality of life.





CANINE CARDIOMYOPATHY

STAGE D

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

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:
 - Discuss typical disease signs of recurrence of heart failure¹⁵
 - Counsel/train owners to monitor home resting respiratory rate (client handouts - <u>Monitoring Your Pet's Respiratory (Breathing)</u> <u>Rate</u>, smart phone applications, etc.)¹⁵
- Follow-up
 - More frequent rechecks may be necessary for dogs with severe arrhythmias
- Follow-up
 - Re-evaluation 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 or increase in home resting or sleeping respiratory rate
 - · Reevaluations are typically more frequent in Stage D

Red text:High priorityBlack text:Lower priority

Abbreviations: CM-cardiomyopathy, CHF-congestive heart failure, SCD-sudden cardiac death, ECG-electrocardiogram