Dilated Cardiomyopathy (DCM) Phenotype – Updated May 2021

INTRODUCTION

Dilated cardiomyopathy (DCM) is the most common cardiomyopathy in the dog and is an important cause of canine morbidity and mortality. [1-3] DCM results in dilation of the cardiac chambers and decreased systolic function, often progressing to congestive heart failure, arrhythmias, and sudden death. Historically, DCM has been considered a predominantly inherited disease common to specific breeds such as the Doberman pinscher, [4-7] Great Dane, [8-9] and Irish wolfhound. [10] A familial link has also been reported in other breeds. [11-29] Other causes of DCM phenotype, such as severe hypothyroid disease, [2--22] tachycardia-induced cardiomyopathy, [23-24] myocarditis/inflammatory cardiomyopathy, [25-28] and nutritional deficiencies [29-31] have been reported less frequently.

DIAGNOSTIC TESTS TO CLASSIFY DCM PHENOTYPE

Any dog diagnosed with presumptive DCM by a primary care veterinarian should be referred to a cardiologist if possible.

Unfortunately for the majority of patients with DCM, this disease is rapidly progressive with no cure. However, the following tests should be considered to understand the etiology of the disease, as some causes of DCM may be treatable and appropriate treatment may lead to improved cardiac function:

1. Echocardiogram – this ultrasound of the heart will confirm a diagnosis of DCM phenotype, as well as help the cardiologist understand the severe of disease and tailor a specific treatment protocol to your dog.

2. Thoracic radiographs – X rays of the chest may be performed by your primary care veterinarian or your cardiologist to evaluate the lungs for the presence of fluid or cancer, and to evaluate the silhouette of the heart.

3. Thyroid panel – some dogs with severe hypothyroid disease will develop poor cardiac function and a DCM phenotype. This is because thyroid hormones have direct and indirect effects on the pump function of the heart. Detection and treatment of hypothyroid disease will improve your dog's quality of life, as well as improve cardiac function in some cases.

4. Cardiac troponin (cTnI) – Infection or inflammation of the heart (myocarditis) can cause cell death. When heart cells die, they release the protein troponin into the blood. Severe elevations of troponin in the blood can indicate the acute phase of myocarditis and help to guide further testing/treatments.

5. Whole blood taurine concentration – Taurine is an amino acid that is important for normal cardiac function. It is recognized as an essential amino acid in cats, but not dogs. However, some dogs with nutritional cardiomyopathy, taurine concentrations are measured to be low, and supplementation is recommended.

6. Complete blood count, serum chemistry, and 4Dx - These are standard blood test to measure the patient's organ function, and to help screen for systemic disease that could alter the course of treatment.

7. 24-hour Holter monitor – A Holter monitor is a wearable ECG device that is placed on the patient with bandage wrap and worn home. The Holter will measure the heart rate and rhythm for 24 hours, in your dog's natural setting. In the context of DCM phenotype, the Holter is placed for 2 reasons. **First,** if there is a suspicion that a tachyarrhythmia (rapid heart rate) may be causing structural cardiac changes, the Holter will offer information on the type of arrhythmia so that an appropriate treatment plan can be recommended. **Second,** dogs with DCM are at risk of dangerous arrhythmias that

can cause sudden death. A Holter monitor will help to screen for these arrhythmias so that proper treatment can be initiated.

CURRENT RESEARCH REGARDING GRAIN FREE DIETS.

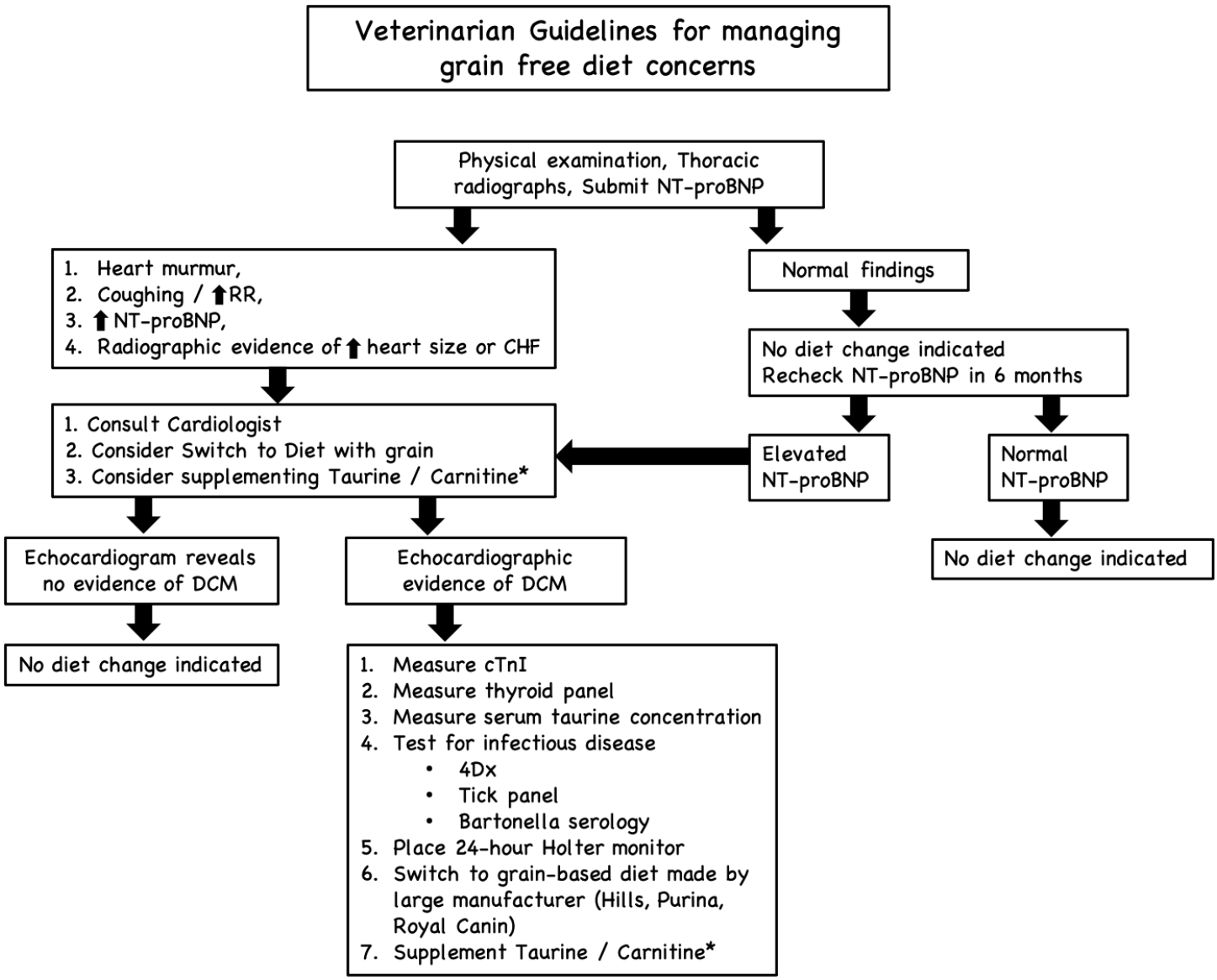
There are currently accumulating reports of DCM phenotype being diagnosed with higher frequency in dog breeds without a known familial link, or in unrelated housemates. This has led to a critical assessment of fed diets. [32-42] Several retrospective reports describing DCM in dogs eating grain-free, legume-rich diets have been published. [34, 37] These studies detail improved cardiac function and longer survival times in dogs treated with a combination of taurine and carnitine supplementation, change to a grain-inclusive diet, and medications specific to their disease. [34-45] Furthermore, the FDA-CVM has released three warnings concerning a correlation between grain-free diets, diets produced by small manufacturers, and DCM. [40-42] No pet food recalls have been issued in association with the warnings. [39-41]

Despite continued research on the topic, a causative mechanism linking grain-free, legume-rich diets and DCM has not been identified. [31-32] However, the identification of a cohort of dogs diagnosed with DCM phenotype, which subsequently improve over time, is intriguing. **This is because dogs diagnosed with DCM typically progressively worsen over time, and improvement is not expected.** It should be noted that in some dogs in the current diet-related studies, improvement was not appreciated after switching diets, underscoring the multifactorial nature of DCM.

CURRENT RECOMMENDATIONS BASED ON CURRENT RESEARCH

The following flow chart is meant to help guide the general practitioner in the diagnosis of occult DCM, particularly in patients being fed grain-free diets.

Feeding grain free, high-legume, exotic ingredient diets is not recommended at this time. However, many dogs do well on these diets with no evidence of cardiac disease. Therefore, if a dog has been eating a specific diet for a long time, with no evidence of cardiac disease, it may not be necessary to switch the diet.



REFERENCES

1. Dutton E *et al*. An update on canine cardiomyopathies – is it all in the genes? *Journal of Small Animal Practice*. 2018;1-10.
2. Sisson D *et al.* Primary myocardial disease in the dog. In: A. S. Ettinger, editor, *Textbook of veterinary internal medicine*. WB Saunders, Philadelphia. 2000;p. 874-895.
3. Buchanan JW. Prevalence of cardiovascular disorders. In: PR Fox, DD Sisson, NS Moise, *Textbook of canine and feline cardiology*. 2nd ed. WB Saunders, Philadelphia. 1999; p. 4577
4. Calvert CA, *et al*. Congestive cardiomyopathy in Doberman Pinscher dogs. *J Am Vet Med Assoc* 1982;181:598–602.
5. Petric AD, *et al.* Dilated cardiomyopathy in Doberman Pinschers: Survival, Causes of Death and a Pedigree Review in a Related Line. *J Vet Cardiol.* 2002 May;4(1):17-24.
6. Mausberg TB, *et al*. A locus on chromosome 5 is associated with dilated cardiomyopathy in Doberman Pinschers. *PLoS One* 2011;6 (5):e20042.
7. Meurs KM, *et al*. A splice site mutation in a gene encoding for PDK4, a mitochrondrial protein, is associated with the development of dilated cardiomyopathy in the Doberman Pinscher. *Hum Genet* 2012;131:1319–25.
8. Meurs KM, *et al*. Clinical features of dilated cardiomyopathy in Great Danes and results of a pedigree analysis: 17 cases (1990-2000). *Assoc* 218:729-732,2001.
9. Meurs KM, *et al*. Clinical features of dilated cardiomyopathy in Great Danes and results of a pedigree analysis: 17 cases (1990-2000). *J Am Vet Med Assoc* 2001;218:729–32.

10. Vollmar AC "The prevalence of cardiomyopathy in the Irish wolfhound: a clinical study of 500 dogs," *Journal of the American Animal Hospital Association.* 2000;36(2):125–132.
11. Tidholm A, *et al*. Dilated cardiomyopathy in the Newfoundland: a study of 37 cases (1983-1994). *J Am Anim Hosp Assoc* 1996;32:465–70.
12. Gooding JP, *et al*. Echocardiographic characterization of dilatation cardiomyopathy in the English Cocker Spaniel. *Am J Vet Res* 1986;47:1978–83.
13. Kittleson MD, *et al*. Results of the multicenter spaniel trial (MUST): taurine- and carnitine-responsive dilated cardiomyopathy in American Cocker Spaniels with decreased plasma taurine concentration. *J Vet Intern Med* 1997;11:204–11.
14. Harpster NK. Boxer cardiomyopathy. A review of the long-term benefits of antiarrhythmic therapy. *Vet Clin North Am Small Anim Pract* 1991;21:989–1004.
15. Meurs KM, *et al*. Association of dilated cardiomyopathy with the striatin mutation genotype in boxer dogs. *J Vet Intern Med* 2013;27:1437–40.
16. Freeman LM, Michel KE, Brown DJ, et al. Idiopathic dilated cardiomyopathy in Dalmatians: nine cases (1990-1995). *J Am Vet Med Assoc* 1996;209:1592–6.
17. Dambach DM, *et al*. Familial dilated cardiomyopathy of young Portuguese water dogs. *J Vet Intern Med* 1999;13:65–71.
18. Sleeper MM, *et al*. Dilated cardiomyopathy in juvenile Portuguese Water Dogs. *J Vet Intern Med* 2002;16:52–62.
19 Legge CH, *et al*. Histological characterization of dilated cardiomyopathy in the juvenile toy Manchester terrier. *Vet Pathol* 2013;50:1043–52.
20. Harmon MW, *et al*. Dilated Cardiomyopathy in Standard Schnauzers: Retrospective Study of 15 Cases. J Am Anim Hosp Assoc. 2017 Jan/Feb;53(1):38-44. doi: 10.5326/JAAHA-MS-6506. Epub 2016 Nov 14. PMID: 27841675.
21. Panciera, D. L. 2001. Conditions associated with canine hypothyroidism. *Vet. Clin. North Am. Small Anim. Pract*. 31:935–950.
22. Phillips DE, *et al*. Hypothyroidism and myocardial failure in two Great Danes. J Am Anim Hosp Assoc. 2003 Mar-Apr;39(2):133-7.
23. O'Brien, *et al*. Rapid ventricular pacing of dogs to heart failure: biochemical and physiological studies. *Can. J. Physiol. Pharmacol*. 1990. ;68:34–39.
24. Wright, K. N., *et al*. Radiofrequency catheter ablation of atrioventricular accessory pathways in 3 dogs with subsequent resolution of tachycardia-induced cardiomyopathy. *J. Vet. Intern. Med*. 1999;13:361–371.
25. Ford, J., *et al*. Parvovirus infection is associated with myocarditis and myocardial fibrosis in young dogs. *Vet. Pathol*. 2017;54:964–971.
26. Santilli, R. A., *et al*. Bartonella-associated inflammatory cardiomyopathy in a dog. *J. Vet. Cardiol*. 2017.;19:74–81.
27. Barr SC, *et al*. Chronic dilatative myocarditis caused by Trypanosoma cruzi in two dogs. J Am Vet Med Assoc. 1989; 195(9):1237-41.
28. Lakhdhir S, *et al*. Clinical presentation, cardiovascular findings, etiology, and outcome of myocarditis in dogs: 64 cases with presumptive antemortem diagnosis (26 confirmed postmortem) and 137 cases with postmortem diagnosis only (2004-2017). J Vet Cardiol. 2020;30:44-56.
29. Kittleson, M. D., *et al*. Results of the multicenter spaniel trial (MUST): taurine- and carnitine-responsive dilated cardiomyopathy in American cocker spaniels with decreased plasma taurine concentration. *J. Vet. Intern. Med*. 1997;11:204–211.
30. Sanderson, S. L. Taurine and carnitine in canine cardiomyopathy. *Vet. Clin. North Am. Small Anim. Pract*. 2006;36:1325–43, vii.
31. Moise NS, *et al*. Dietary taurine deficiency and dilated cardiomyopathy in the fox. *Am Heart J*. 1991;121(2 Pt 1):541-7.
32. Mansilla WD, *et al*. Special topic: The association between pulse ingredients and canine dilated cardiomyopathy: addressing the knowledge gaps before establishing causation1. *J Anim Sci.* 2019;97(3):983-997.
33. McCauley SR, *et al*. Review of canine dilated cardiomyopathy in the wake of diet-associated concerns. *J Anim Sci*. 2020;98(6):skaa155.
34. Freid, KJ, *et al*. Retrospective study of dilated cardiomyopathy in dogs. *J Vet Intern Med*. 2021; 35: 58– 67.
35. Adin D, *et al*. Effect of type of diet on blood and plasma taurine concentrations, cardiac biomarkers, and echocardiograms in 4 dog breeds. *J Vet Intern Med*. 2021 Feb 27.
36. Adin D, *et al*. Echocardiographic phenotype of canine dilated cardiomyopathy differs based on diet type. *J Vet Cardiol*. 2019;21:1-9.
37. Walker AL *et al*. Association of diet with clinical outcomes in dogs with dilated cardiomyopathy and congestive heart failure, *Journal of Veterinary Cardiology*, 2021, in press.
38. Kaplan JL, *et al.* Taurine deficiency and dilated cardiomyopathy in golden retrievers fed commercial diets. *PLoS One*. 2018;13(12):e0209112.
39. Ontiveros ES, *et al*. Development of plasma and whole blood taurine reference ranges and identification of dietary features associated with taurine deficiency and dilated cardiomyopathy in golden retrievers: A prospective, observational study. *PLoS One*. 2020;15(5):e0233206.
40. US FDA. FDA Investigation into Potential Link between Certain Diets and Canine Dilated Cardiomyopathy. Jun 27, 2019. Available from: https://www.fda.gov/animal- veterinary/news-events/fda-investigation-potential-link-between-certain-diets-and- canine-dilated-cardiomyopathy.
41. US FDA. FDA Provides Update on Investigation into Potential Connection Between Certain Diets and Cases of Canine Heart Disease. Feb 19, 2019. Available from: https://www.fda.gov/animal-veterinary/cvm-updates/fda-provides-update- investigation-potential-connection-between-certain-diets-and-cases-canine-heart.
42. US FDA. Vet-LIRN Update on Investigation into Dilated Cardiomyopathy. Jun 27, 2019. Available from: https://www.fda.gov/animal-veterinary/science-research/vet-lirn-update- investigation-dilated-cardiomyopathy.
43. Freeman LM, *et al*. Diet-associated dilated cardiomyopathy in dogs: what do we know? *J Am Vet Med Assoc*. 2018;253(11):1390-1394.
44. Kaplan JL, *et al*. Taurine deficiency and dilated cardiomyopathy in golden retrievers fed commercial diets [published correction appears in PLoS One. 2018 Dec 31;13(12):e0210233]. *PLoS One*. 2018;13(12):e0209112.
45. Ontiveros ES, *et al*. Development of plasma and whole blood taurine reference ranges and identification of dietary features associated with taurine deficiency and dilated cardiomyopathy in golden retrievers: A prospective, observational study. *PLoS One*. 2020;15(5):e0233206.