

# Nutritional Therapy in the Treatment of Heart Disease in Dogs

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## Abstract

A number of diseases affecting the heart are prevalent in canines. Acquired diseases, those which develop over the course of an animal's lifetime (rather than congenital defects present at birth), have recently been the subject of several studies to determine the efficacy of dietary supplementation on symptom presentation, disease severity, and mortality rates. Specifically, coenzyme Q10 (CoQ10), vitamin E (as alpha-tocopherol), L-carnitine, taurine, and fish oil (omega-3 fatty acids) have all been evaluated in the prevention and treatment of many types of heart disease in dogs. Other supplements with preliminary evidence, meriting further investigation, include magnesium, Crataegus, and the B vitamins. Both clinical observation and interventional trials with various breeds have provided clear evidence for the benefit of numerous supplements on canine heart disease. Appropriate levels of certain dietary nutrients have been shown to increase life span, improve life quality, reduce symptoms and physical evidence of disease, and decrease mortality rates in these animals.

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## Introduction

Decades of research on human cardiovascular disease and its successful treatment have provided insight into the relationship of certain dietary nutrients and their function in maintaining heart health. There is recent evidence suggesting these vitamins and micronutrients, both as adjuvant use and possibly as replacement for some traditional medications, also deserve attention in veterinary applications.<sup>1</sup> A review of the current literature and research studies provides a good basis from which to determine the usefulness of many cardioprotective compounds for animals. These compounds include the antioxidant vitamins such as E and the B complex vitamins, in addition to nutrients such as coenzyme Q10 (CoQ10), L-carnitine, taurine, magnesium, fish oil, and Crataegus extract. Investigation into the important role of nutrition in the pathogenesis and treatment of heart disease in dogs has provided new therapeutic options for the veterinarian and pet owner alike.

## Types and Symptoms of Acquired Heart Disease in Dogs

Canine cardiovascular disease can involve one or more heart structures. There are a number of primary disease types for which nutritional supplementation is considered effective treatment. These include diseases of the heart valves (mitral regurgitation and valvular disease),

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ventricles (primary diastolic dysfunction), heart muscle tissue (cardiac hypertrophy, dilated and restrictive cardiomyopathy, congestive heart failure), and those due to abnormal electrical activity (cardiac arrhythmias), ischemic and reperfusion damage, and non-fatal infarcts. Unless a specific disease state is designated, “heart disease” will be used throughout this article to refer to a generic state of acquired heart dysfunction leading to compromised health.

Heart failure is the state wherein the heart cannot meet the metabolic needs of the body’s tissues. This usually occurs in the presence of elevated left ventricular pressures at end diastole. Heart failure may occur in conditions where the heart is producing a normal cardiac output, but is still insufficient to meet the metabolic needs of the dog due to increased tissue requirements, such as in states of anemia. In these instances, heart disease can occur secondary to conditions where the strength of the heart muscle appears normal. However, most conditions that result in heart failure occur as a result of a significantly weakened left or right ventricle, or both.

Congestive heart failure occurs when the volume of blood introduced into the heart is in excess of the heart’s capacity to pump it back out to the body. If this inability is due to left ventricle dysfunction, it typically results in elevated pulmonary venous pressures and pulmonary congestion leading to edema as fluid builds up behind the heart. This can lead to pleural and abdominal effusion. If the impairment exists in the right ventricle or the pulmonary arteries, congestion occurs behind the right heart (causing pleural effusion and/or ascites). Many, but not all, cases of heart failure include congestive heart failure.

In some dogs, no evidence of illness is apparent, especially in the early stages of heart disease. However, signs of left-sided congestive heart failure (fluid accumulation in the lung or pulmonary edema) are often present.

These signs can include lethargy, decreased activity level or exercise ability, dyspnea, wheezing, cough, and orthopnea. Abrupt weakness, collapsing episodes, and even sudden death due to disturbances in heart rhythm can also occur. The development of left- and right-sided congestive heart failure with ascites can create greater respiratory effort and cause abdominal distention. Once fluid accumulations have occurred, clinical heart failure is present and intervention must be taken.

### Cause and Prevalence of Acquired Heart Disease in Dogs

According to information disseminated by the American Veterinary Medical Association, one in ten dogs has heart disease.<sup>2</sup> While some animals have a genetic predisposition toward the development of heart disease, many develop degenerative heart conditions as a result of multiple dietary factors, including nutritional deficiencies, obesity, or cachexia. The pathology of one of the most commonly investigated canine cardiac diseases, idiopathic dilated cardiomyopathy, characterized by left ventricular dilation and systolic dysfunction, may have a direct correlation to deficiencies of taurine and L-carnitine in many breeds.<sup>3,4</sup> Similar findings reveal a relationship between the development of congestive heart failure and inadequate levels of CoQ10.<sup>5</sup>

Certain types of heart disease are common to specific breeds of dog. As many as 28 percent of Doberman pinchers are reported to be afflicted with dilated cardiomyopathy (DCM). Similarly, American cocker spaniels, Portuguese water dogs, and Boxer dogs are at particularly high risk for the development of DCM.<sup>4</sup> Consequently, a relatively large amount of research data on cardiac treatment exists for these specific canine groups.

Unfortunately, many drugs currently used in the treatment of heart disease in dogs have significant disadvantages. The use of

diuretics to reduce fluid accumulation (as in pulmonary edema) may decrease the contractile performance of the heart and contribute to arrhythmias. This is due to hypovolemia, electrolyte imbalance (especially hypokalemia), and acid-base imbalance (particularly metabolic alkalosis). Venodilator therapy works by shifting the volume of blood from the heart into peripheral circulation, which reduces pulmonary edema. However, this therapy can cause severe hypotension, particularly in animals with an already reduced stroke volume (especially if used in conjunction with diuretics). Positive inotropes are used to increase the heart's contractile ability, but are thought to exacerbate hypertrophic cardiomyopathy and to cause arrhythmias.

While there is definite indication for use of these and other pharmaceutical treatments in certain instances of the disease, other options are available that do not have adverse side effects. Nutritional supplements as a replacement for all or part of conventional veterinary heart disease medications have been shown to be helpful in many cases.

### **Nutritional Supplementation for Canine Cardiac Disease**

There are two major aspects of nutritional therapy for canine heart disease: First, to correct for dietary deficiencies that lead to the disease, and second, to possess active cardioprotective properties that decrease severity of the disease in animals already affected.

Many vitamins and micronutrients are presently under investigation regarding their mechanisms of action. However, taking the results of current research as an indication, the scientific community is beginning to seriously consider the beneficial role of nutritional supplementation in the treatment of cardiovascular disease in animals.

### **Coenzyme Q10**

A fat-soluble quinone, found most commonly in the inner mitochondrial membrane, CoQ10 is essential to a number of cellular processes, including the synthesis of adenosine triphosphate (ATP) as an electron carrier in respiration and oxidative phosphorylation. It is also thought to act as a cellular membrane-stabilizer, and to possess free-radical scavenging abilities,<sup>6</sup> suppressing the formation of reactive oxygen species during lipid peroxidation that is implicated in the pathogenesis of degenerative heart disease.<sup>7</sup> In addition, both *in vitro* and animal studies have demonstrated CoQ10's ability to protect heart tissue from functional and structural changes resulting from ischemia and reperfusion.<sup>8</sup> The rate and magnitude of clinical improvement appears to be directly related to the use of higher doses of CoQ10.<sup>9</sup>

CoQ10 can be successfully absorbed through the gastrointestinal tract, with oral dosing increasing the concentration in the blood and organ tissue.<sup>10</sup> There have been no findings to indicate CoQ10 supplementation causes adverse side effects or toxicity in animals<sup>11</sup> or humans.<sup>12</sup> Supplementing the diet of dogs which had experimentally-induced congestive heart failure with CoQ10 was found to decrease hypertrophy and reduce myocardial injury.<sup>13-14</sup> Maintaining adequate myocyte nutrition and enhancing myocardial function by dietary addition of CoQ10 in cases of canine heart disease can be important in decelerating disease progression and improving overall heart health.

### **Vitamin E**

Alpha-tocopherol, a biologically active form of vitamin E, has been shown to have a beneficial antioxidant effect in animals when given orally, probably due to its ability to inhibit free-radical mediated damage to the myocardium. Vitamin E prevents oxidation of low-density lipoproteins and promotes normal coronary artery dilation.<sup>15</sup>

An inverse correlation exists between plasma vitamin E concentration and the severity and incidence of heart disease in dogs.<sup>16</sup> Pretreatment with alpha-tocopherol (1,000 IU/kg body weight for ten days) prior to experimentally-induced ischemia and reperfusion was shown to significantly reduce the size of the infarct in dogs as compared with a control group that did not undergo pretreatment.<sup>17</sup> In a similar study, ingesting alpha-tocopherol was found to prevent lethal ventricular arrhythmias associated with ischemia and reperfusion.<sup>18</sup> The addition of vitamin E to the diet of dogs – 40 IU/kg/day over a period of four months – prevented volume overload-induced decrease in myocardial contractility, and increased cardiac antioxidant reserves and glutathione peroxidase activity.<sup>19</sup>

It is worth noting that pet food containing significant quantities of unsaturated fats which is stored for a long period of time should be considered depleted of vitamin E (due to alpha-tocopherol's instability to oxygen and UV light), and can contribute to deficiencies.<sup>20</sup> Current clinical evidence is adequate to recommend therapeutic administration of alpha-tocopherol to animals diagnosed with, or at high risk for, heart disease. Although its exact mechanism of cardioprotection is yet to be determined, vitamin E supplementation appears to provide benefits for animals with compromised cardiovascular function.

### **L-carnitine**

L-carnitine, a trimethylated amino acid, transports long-chain fatty acids to beta-oxidation sites in the mitochondrial matrix and is essential to normal cellular energy metabolism. Deficiency results in development of cardiomyopathy in several breeds of dogs.<sup>21</sup> Of all antioxidant and cardioprotective compounds studied, L-carnitine, typically used in combination with taurine, has shown the greatest direct effect on improving life expectancy and mortality rates in some animals with congestive heart disease. These results may vary

greatly from breed to breed.

Studies on Boxer dogs have shown the efficacy of oral supplementation with carnitine.<sup>22-23</sup> Families of dogs diagnosed with dilated cardiomyopathy were found to have decreased concentrations of myocardial L-carnitine when compared to control groups. When the diets of these dogs were supplemented with high doses of L-carnitine, their health and myocardial function improved greatly; removal of the supplemental L-carnitine caused a return of myocardial dysfunction and clinical signs of dilated cardiomyopathy.<sup>23</sup> Additional research shows that carnitine supplementation in dogs with taurine deficiency can allow conventional cardiovascular drug therapy to be discontinued in some cases. While myocardial function did not completely return to normal in all animals treated with carnitine therapy, it provided the dogs a normal quality of life for months to years.<sup>4</sup>

L-carnitine can improve heart rate, lipid patterns, and exercise tolerance, and protect against cardiac necrosis, all of which are important to returning an animal to normal cardiac function. It is valuable to understand L-carnitine in relation to taurine deficiency and supplementation, as the two nutrients have interrelated roles in management of heart disease in dogs.<sup>24</sup>

### **Taurine**

Taurine, an amino acid found in relatively high concentration in heart tissue, is closely linked with cardiovascular health. It is thought that taurine works as a cardioprotectant by regulating natriuresis and diuresis, exhibiting positive inotropic effects on myocytes, and minimizing the adverse effects of angiotensin II.<sup>25</sup> Taurine has also been shown to decrease the level of lipid peroxides (and hence, oxidative damage) in hypoxic tissues,<sup>26</sup> and exert anti-arrhythmic effects in cardiac muscle.<sup>27</sup>

Taurine supplementation, at 100 mg/kg/daily over the course of a month, reduced

mortality rates, improved clinical condition, and enhanced myocardial contractility in dogs with congestive heart failure as compared to controls.<sup>28</sup> Other researchers have found taurine to slow the rapid progression of heart failure and prolong life expectancy in animals.<sup>29</sup>

In several breeds, taurine deficiency is thought to be one of the leading factors in the pathogenesis of canine (and feline) heart disease; specifically, dilated cardiomyopathy. This is noted especially for breeds such as the American cocker spaniel, Portuguese water dog, and Doberman pincher.<sup>3,30</sup> These relationships highlight taurine as potentially one of the most important nutrients under consideration for nutritional supplementation. It is an effective cardiogenic compound, especially where deficiency exists.

### **Omega-3 fatty acids**

The omega-3 fatty acids, eicosapentanoic acid and docosahexanoic acid, are found almost exclusively in seafood, and especially fish oil from oily, cold water fish such as herring and mackerel. Fish oil possesses hypotriglyceridemic, anti-inflammatory, hypotensive, antiarrhythmic, antivasopressor, and anti-intimal thickening activities.<sup>31-33</sup> Because these compounds are not produced endogenously, they must be introduced by means of the diet or intravenous infusion. Oral supplementation has been found to be as effective as intravenous administration in producing antiarrhythmic actions in dogs with pre-existing heart disease, even though it is not as direct a route of action. When ingested, the fatty acids are initially stored in the membrane phospholipids of the heart, brain, and other tissues where they are not cardioprotective. However, in cases of ischemia, exertion, or major sympathetic adrenergic discharge, the stored fatty acids are quickly liberated by phospholipases and lipases, allowing them to act as in their free form to prevent arrhythmias.<sup>32</sup>

Investigational studies with dogs have

consistently shown the benefit of omega-3 fatty acid supplementation for a number of vaso-occlusive heart conditions.<sup>34</sup> Recent studies attribute the antiarrhythmic actions of the omega-3 fatty acids to their ability to alter the electrophysiology of cardiac cells.<sup>35</sup> Because the fatty acids bind directly to the protein of the sodium channels in the cell membrane, the electrical activity of individual myocytes is stabilized, requiring a stronger electrical charge to cause an action potential, which in turn allows the channels to remain inactive for a longer period of time.<sup>36</sup> This results in a reduction in left ventricular systolic pressure, slower resting pulse rate, increased PR (atrial-ventricular conduction time), and shortened QT (electrical action potential duration) intervals, with an overall decrease in evidence of ischemia.<sup>32,37</sup>

The results of these mechanisms are evident in the dog model of cardiac sudden death, studied in dogs with left ventricular infarction. Treatment with fish oil concentrate prevented ischemia-induced fatal ventricular arrhythmias in 77 percent of the dogs observed in the study.<sup>32</sup> In a separate trial, dogs with naturally occurring heart disease were studied to test the ability of omega-3 fatty acids to reduce cytokines and improve clinical outcome. Fish oil supplementation markedly improved cachexia and decreased interleukin-1 beta concentrations in dogs treated with fish oil as compared with the placebo group.<sup>38</sup>

Omega-3 fatty acids exhibit the ability to prevent fatal arrhythmias and improve general health in animals with congestive heart disease, and should be considered an essential nutrient for maintaining control of cardiac function in diseased dogs. Dietary supplementation with fish oil concentrate is an effective means of introducing these nutrients, and should be considered as supportive care for dogs diagnosed with heart disease.<sup>33</sup> Table 1 summarizes the most important nutrients for supplementation in dogs with cardiovascular disease.

**Table 1.** Nutrients for Cardiovascular Disease in Dogs

NUTRIENT	DOSE	MECHANISM OF ACTION
CoQ10	100-400 mg daily	Electron carrier in cellular respiration and oxidative phosphorylation; antioxidant
L-carnitine	500-2000 mg daily	Transports long-chain fatty acids to beta-oxidation sites in the mitochondria
Taurine	500-1500 mg daily	Regulates natriuresis and diuresis; has a positive inotropic effect on myocytes; decreases lipid peroxidation
Omega-3 fatty acids	500-2000 mg daily	Lower triglycerides; have anti-inflammatory, hypotensive, antiarrhythmic, antivasopressor, and anti-intimal thickening effects
Vitamin E	200-500 IU daily	Prevents LDL oxidation and free-radical mediated damage to the myocardium

### Other Dietary Factors

Several other vitamins and micronutrients are also thought to play important roles in the treatment of heart disease in dogs. The B vitamins (folate, B6, B12), magnesium, and bioflavonoid-containing compounds are worthy of additional investigation for use in veterinary heart disease therapy.<sup>32-35</sup>

Magnesium is thought to have a direct cardioprotective effect in dogs with acute myocardial infarction due to its antiarrhythmic and antithrombotic actions. However, the uncertainty regarding a usable clinical dosage, versus the high doses used in experimental studies, warrants further examination of its real merit in veterinary applications.<sup>43</sup> It is also believed there is a correlation between magnesium deficiency in dogs and the development of mitral valve prolapse, although this hypothesis is still under investigation.<sup>44</sup>

Recent studies have investigated the cardioprotective effects of hawthorne (*Crataegus oxyantha*). Bolus injection of extracts (in ethylacetate and hydroalcohol) of the flowering tops of *Crataegus meyeri* A. Pojark caused a significant reduction in blood pressure in rats subsequent to a period of myocardial ischemia, showing hypotensive and potentially antiarrhythmic activity on ischemic myocardium.<sup>45</sup> Similar findings were evident following a three-month trial in which rats were fed a dried extract of *C. oxyantha* prior to induced ischemia. In the group that underwent the longest duration of ischemia (20 minutes), the prevalence of arrhythmias was significantly reduced in rats pretreated with *Crataegus* as compared with controls.<sup>46</sup> Additional studies need to be conducted to determine the applicability of hawthorne in the treatment of canine heart disease; although, evidenced by its effectiveness in other animal

models in preventing reperfusion arrhythmias, there is reason to believe it could be beneficial for dogs as well.

There is a lack of clinical trials pertaining to the direct relationship between the B vitamins and their role in canine heart disease. This is an area requiring further studies in order to elucidate the potential benefit folate, B6, and B12 may have for dogs diagnosed with heart disease.

## Conclusion

Based on the results of current clinical trials and therapeutic interventions, dietary supplementation with CoQ10, vitamin E, L-carnitine, taurine, and fish oil is indicated for the treatment of many types of heart disease in dogs. However, examination and diagnosis on an individual case basis is necessary to make recommendations for proper nutrient dosages and treatment frequency for a specific animal. Supplementation amounts may vary with a dog's breed, age, and disease type and severity.

The area of veterinary heart disease therapeutics warrants additional research before concrete conclusions can be drawn regarding the mechanism and usefulness of certain micronutrients. Nonetheless, nutritional therapy should be considered to be a viable and desirable option for improving the quality of life and reducing heart failure mortality in dogs.

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