

# Left-Sided Congestive Heart Failure

**Jessica McGinnis, DVM**

University of Florida College of Veterinary Medicine

**Amara Estrada, DVM, DACVIM (Cardiology)**

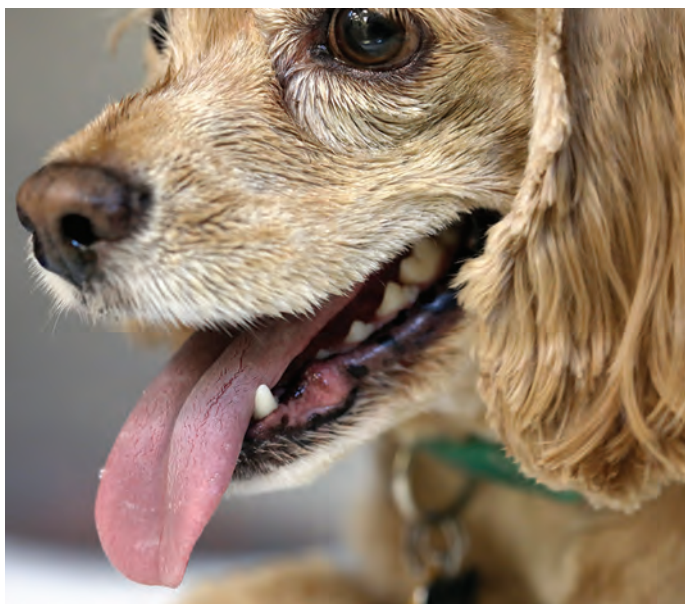
University of Florida College of Veterinary Medicine

Left-sided congestive heart failure (L-CHF) is a life-threatening condition caused by venous congestion secondary to increased left atrial pressure. This pressure occurs when the left ventricle is unable to adequately fill with or eject blood because of a primary structural or functional cardiac condition.<sup>1</sup>

L-CHF patients may initially show no clinical signs; however, those that present with acute dyspnea *must* receive appropriate treatment before undergoing testing to establish the diagnosis. (See **Table 1**, page 36, for a list of common conditions that cause L-CHF in dogs and cats.)

## Clinical Signs

Cats and dogs may appear clinically normal in the early compensatory phase of L-CHF. Monitoring



sleeping respiratory rates (SRR) at home can help detect early L-CHF in patients with known cardiac disease. A sustained SRR of more than 30 breaths per minute may be indicative of potential decompensated CHF.<sup>2</sup> As the disease progresses and the patient reaches the decompensated phase of L-CHF, pulmonary edema can cause tachypnea and increased inspiratory effort.<sup>3</sup> In cats, pleural effusion can also be present, resulting in short, shallow breathing with increased inspiratory effort.<sup>1</sup> Dogs with L-CHF can develop tachycardia as the heart compensates to increase cardiac output.<sup>3</sup>

Thoracic auscultation may disclose crackles or harsh bronchovesicular sounds in dogs and cats with pulmonary edema and decreased bronchovesicular sounds ventrally in cats with pleural effusion.<sup>1,3</sup> The absence of these findings, however, does not rule out

See related article, **Drugs in Brief: Pimobendan**, page 33

the presence of L-CHF. Cats, for example, do not breathe deeply enough to manifest obvious pulmonary crackles even with severe dyspnea. Decreased rectal temperature, pale mucous membranes, and prolonged capillary refill time because of vasoconstriction and decreased peripheral perfusion may also be observed, and cardiac arrhythmias may be present, depending on the underlying condition.<sup>1,3</sup> Coughing does not always indicate that a dog with cardiac disease has L-CHF, as small dogs frequently have a paroxysmal-to-sustained cough related to compression of the mainstem bronchus secondary to cardiac enlargement.<sup>4</sup> In these patients, thoracic radiography is needed to establish the diagnosis and guide treatment.

Patients with acute dyspnea should undergo aggressive stabilizing treatment before any ancillary diagnostic testing is performed.

**TABLE 1** | **Common Primary Cardiac Conditions Causing Left-Sided Congestive Heart Failure in Dogs & Cats**

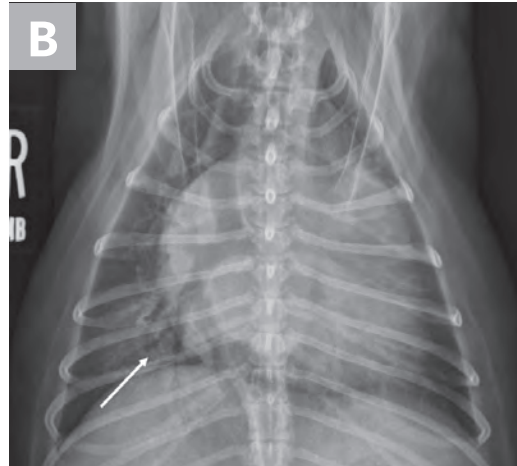
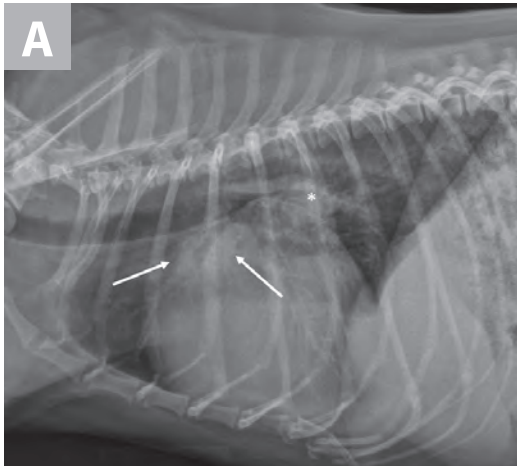
Condition	Effect	Species & Breed
Myxomatous mitral valve disease	Increased left atrial pressure	<ul style="list-style-type: none"> <li>• Cavalier King Charles spaniel</li> <li>• Chihuahua</li> <li>• Miniature pinschers</li> <li>• Yorkshire terrier</li> <li>• Other small-breed dogs</li> </ul>
Dilated cardiomyopathy <sup>4,16</sup>	Increased left atrial pressure	<ul style="list-style-type: none"> <li>• Doberman pinscher</li> <li>• Boxer</li> <li>• Great Dane</li> <li>• German shepherd dog</li> <li>• Labrador retriever</li> <li>• Other large- &amp; giant-breed dogs</li> </ul>
Hypertrophic cardiomyopathy <sup>1</sup>	Thickening of the left ventricle	<ul style="list-style-type: none"> <li>• Cats<sup>17</sup> <ul style="list-style-type: none"> <li>–Maine coon</li> <li>–Persian</li> <li>–American domestic shorthair</li> </ul> </li> </ul>

## Diagnosis

If clinical signs are not immediately life-threatening, at a minimum, a lateral thoracic radiograph should be obtained. Thoracic radiography is the gold standard for diagnosing pulmonary edema and venous congestion secondary to L-CHF.<sup>3,5</sup> If the patient is not in distress, a 3-view study with a ventrodorsal or dorsoventral (VD/DV) view and opposite lateral thoracic views is ideal. Characteristic findings of cardiogenic pulmonary edema include increased interstitial-to-alveolar infiltrates of the perihilar and/or caudodorsal lung field in dogs.<sup>3,5</sup> (See **Figures 1A** and **1B**.)

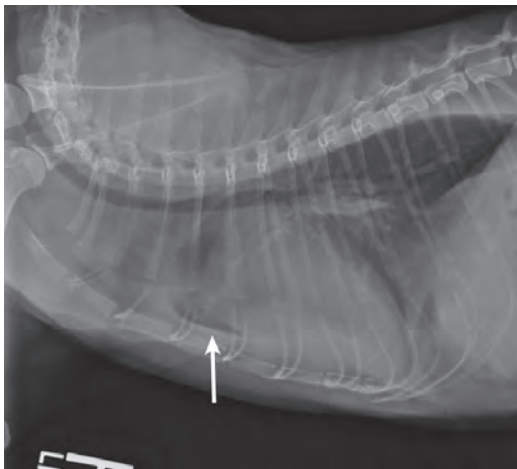
In cats, a ventral or diffuse interstitial-to-alveolar pattern may be present<sup>3,5</sup>; pleural effusion is indicated by pleural fissure lines, retraction of the lung lobes, and effacement of the cardiac silhouette.<sup>6</sup> (See **Figure 2**.) Dyspneic cats with evidence of pulmonary infiltrates should receive a presumptive diagnosis of cardiogenic pulmonary edema until proven otherwise (often by a clinical diuretic trial).

Left atrial enlargement is typically present in both cats and dogs with L-CHF. In dogs, left atrial enlargement typically appears in radiographs as a rounded increased opacity caudal to the carina in the perihilar region on the lateral projection. (See **Figure 1A**.) Generalized cardiomegaly is identified by measuring vertebral heart score (VHS).<sup>3,5</sup> (See **Figure 3**.) In cats, both generalized cardiomegaly and left atrial enlargement are more difficult to assess because of their more subtle radiographic changes; they are characterized by a VHS score greater than 8 and the presence of a valentine-shaped heart on the VD/DV projection, respectively. However, normal left atrial size on thoracic radiography

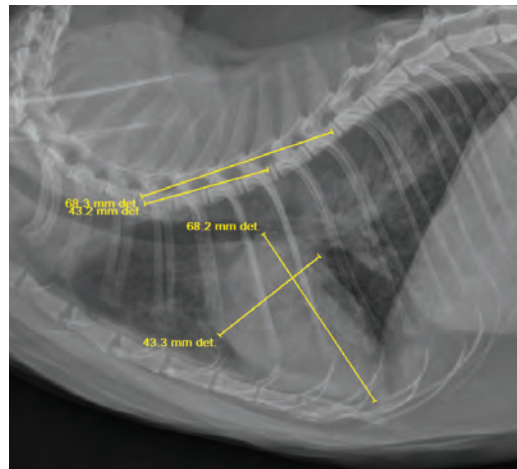


▲ **FIGURE 1** (A) L-CHF in a Cavalier King Charles spaniel with mitral valve disease. Enlarged pulmonary veins are marked by the arrows. Enlarged left atrium is marked with an asterisk. (B) DV projection shows a caudal interstitial-to-alveolar pattern with air bronchograms (arrow).

*Images courtesy of University of Florida Small Animal Hospital*



▲ **FIGURE 2** L-CHF in a cat with cardiomegaly and pleural effusion with visible pleural fissure line (arrow).



▲ **FIGURE 3** VHS of 10.5 in a cat. Normal VHS for cats and dogs is less than 8.0 and less than 10.5, respectively.

Note the diffuse interstitial-to-alveolar lung pattern, which most likely represents cardiogenic pulmonary edema.

**Characteristic findings of cardiogenic pulmonary edema include increased interstitial-to-alveolar infiltrates of the perihilar and/or caudodorsal lung field in dogs.**

does not rule out the presence of L-CHF in dyspneic cats.<sup>1</sup> Once acute L-CHF has been identified and treated, evaluation by a cardiologist is recommended, but stabilization of the patient is the first priority.

Additional initial diagnostics include blood pressure measurement and renal and electrolyte studies to assess the patient's perfusion and kidney function before initiating diuretic therapy.<sup>1,3,7</sup> Additionally, an NT-proBNP ELISA SNAP test can be performed when the diagnosis of L-CHF is in question.

NT-proBNP is a biomarker that, when present, can indicate the presence of cardiac remodeling. In recent studies, the point-of-care SNAP test has been shown to have a 65% sensitivity and 100% specificity.<sup>8</sup> However, these studies did not include normal cats and specificity results may have been skewed. Nevertheless, a positive NT-proBNP SNAP test can raise clinical suspicion of L-CHF and prompt the practitioner to treat accordingly.

## TAKE ACTION

- 1** Always provide appropriate treatment to patients that present with acute dyspnea before testing to establish an L-CHF diagnosis.
- 2** Consider that L-CHF is often life-limiting and include quality of life when making a treatment and care plan.

## Resource

- Cardiac Education Group. [cardiaceducationgroup.org](http://cardiaceducationgroup.org)

## Treatment

Acute L-CHF is treated with oxygen supplementation and diuretic therapy.<sup>1,3,7,9</sup> (See **Figure 4**.) Oxygen can be administered via flow-by, oxygen cage, or nasal oxygen cannulas and should be provided until the patient is eupneic in room air (ie, 21% oxygen).<sup>1,3</sup> In cats, empiric treatment with an albuterol inhaler can also be considered; however, this should be avoided if proven that it adds extra stress to the patient.

Furosemide is the initial diuretic of choice and should be administered at 2 to 4 mg/kg IV.<sup>1,3,7</sup> If IV access is not possible because of patient distress, furosemide can be administered IM.<sup>9</sup> Maximal effect is expected within 30 minutes of IV administration and within 1 to 2 hours of IM administration.<sup>7,9</sup> Diuretic therapy should aim to relieve respiratory distress. Repeat bolus doses can be administered every 30 minutes until the desired effect is achieved. Ideally, the total daily dose of furosemide should not exceed 12 mg/kg.<sup>1</sup>

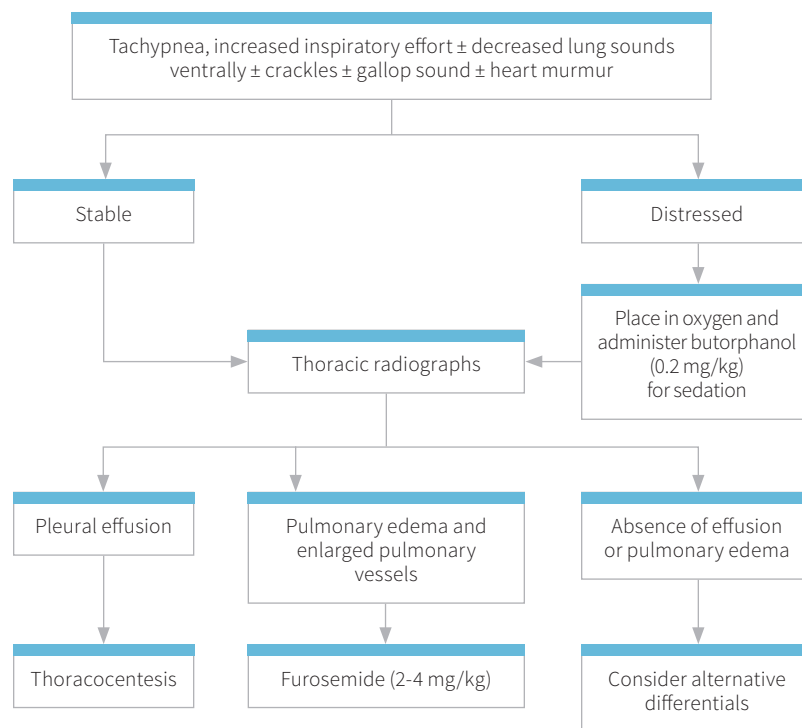
If repeat bolus doses are required, a furosemide CRI at a rate of 0.66 to 1.0 mg/kg/h may be considered.<sup>1,3</sup> Thoracocentesis is recommended in cats with clinically significant pleural effusion.<sup>1</sup> Because azotemia and hypokalemia may develop with the use of a loop diuretic (eg, furosemide), renal and electrolyte values should be monitored daily in hospitalized patients receiving treatment for acute L-CHF. These values should be rechecked within 1 week of initiating oral furosemide dosing at home.<sup>1,3,7</sup> Note that IV fluid therapy is contraindicated in the treatment of L-CHF.

Patients are considered to be in compensated L-CHF once they are eupneic in room air. Long-term treatment of compensated L-CHF includes oral administration of furosemide and an ACE inhibitor and treatment of the underlying condition.<sup>1,3,7</sup> Use of pimobendan, a positive inotrope, is recommended in dogs with stage B2 and C myxomatous mitral valve disease and dogs with dilated cardiomyopathy. Pimobendan has been shown to prolong the time to onset and recurrence of L-CHF.<sup>10-13</sup> No prospective literature supports the use of pimobendan in cats, but retrospective studies have suggested a potential benefit of this drug in cats with hypertrophic cardiomyopathy and L-CHF, especially those with systolic dysfunction and without systolic anterior motion of the mitral valve.<sup>14,15</sup>

## Conclusion

L-CHF is often a life-limiting disease. However, patients who receive an initial diagnosis of L-CHF have an approximate survival-to-discharge rate of 80%, and patients typically have a good quality of life during treatment of compensated L-CHF.<sup>1</sup> (See **Resource**.)

In a well-managed patient naïve to previous cardiac medications, the average survival time with L-CHF is 6 to 12 months.<sup>1,11</sup> SRR is a valuable parameter for owners to measure at home and, when increased, indicates the need for prompt treatment.<sup>2</sup> Continued follow-up care, including repeat measurement of renal and electrolyte values, thoracic radiography (if indicated), and echocardiography is an important aspect of L-CHF management. ■



▲ **FIGURE 4** Algorithm for recognizing, diagnosing, and treating feline CHF.

## References

1. Ferasin L, DeFrancesco T. Management of acute heart failure in cats. *J Vet Cardiol*. 2015;17(suppl 1):S173-S189.
2. Porciello E, Rishniw M, Ljungvall I, Ferasin L, Haggstrom J, Ohad DG. Sleeping and resting respiratory rates in dogs and cats with medically controlled left-sided congestive heart failure. *Vet J*. 2016;207:164-168.
3. Mazzaferro EM. Emergency management of congestive heart failure [published online October 1, 2005]. *Veterinary Medicine*. 2005;100(10):734-741.
4. Atkins C, Bonagura J, Ettinger S, et al. Guidelines for the diagnosis and treatment of canine chronic valvular heart disease. *J Vet Intern Med*. 2009;23:1142-1150.
5. Guglielmini C, Diana A. Thoracic radiography in the cat: identification of cardiomegaly and congestive heart failure. *J Vet Cardiol*. 2015;17(suppl 1):S87-S101.
6. Stillion JR, Letendre JA. A clinical review of the pathophysiology, diagnosis, and treatment of pyothorax in dogs and cats. *J Vet Emerg Crit Care (San Antonio)*. 2015;25(1):113-129.
7. Gordon SG, Côté E. Pharmacotherapy of feline cardiomyopathy: chronic management of heart failure. *J Vet Cardiol*. 2015;17(suppl 1):S159-S172.
8. Harris AN, Beatty SS, Estrada AH, et al. Investigation of an N-terminal prohormone of brain natriuretic peptide point-of-care ELISA in clinically normal cats and cats with cardiac disease. *J Vet Intern Med*. 2017;31(4):994-999.

9. Harada K, Ukai Y, Kanakubo K, et al. Comparison of the diuretic effect of furosemide by different methods of administration in healthy dogs. *J Vet Emerg Crit Care (San Antonio)*. 2015;25(3):364-371.
10. Boswood A, Häggström J, Gordon G, et al. Effect of pimobendan in dogs with preclinical myxomatous mitral valve disease and cardiomyopathy: the EPIC study—a randomized clinical trial. *J Vet Intern Med*. 2016;30(6):1765-1779.
11. Häggström J, Boswood A, O'Grady M, et al. Effect of pimobendan or benazepril hydrochloride on survival times in dogs with congestive heart failure caused by naturally occurring myxomatous mitral valve disease: the QUEST study. *J Vet Intern Med*. 2008;22(5):1124-1135.
12. O'Grady MR, Minors SL, O'Sullivan ML, Horne R. Effect of pimobendan on case fatality rate in Doberman pinschers with congestive heart failure caused by dilated cardiomyopathy. *J Vet Intern Med*. 2008;22(4):897-904.
13. Summerfield NJ, Boswood A, O'Grady MR, et al. Efficacy of pimobendan in the prevention of congestive heart failure or sudden death in doberman pinschers with preclinical dilated cardiomyopathy (the PROTECT study). *J Vet Intern Med*. 2012;26(6):1337-1349.
14. Gordon SG, Saunders AB, Roland RM, et al. Effect of oral administration of pimobendan in cats with heart failure. *J Am Vet Med Assoc*. 2012;241(1):89-94.
15. Reina-Doreste Y, Stern JA, Keene BW, et al. Case-control study of the effects of pimobendan on survival time in cats with hypertrophic cardiomyopathy and congestive heart failure. *J Am Vet Med Assoc*. 2014;245(5):534-539.
16. Simpson S, Edwards J, Ferguson-Mignan TFN, Cobb M, Mongan NP, Rutland CS. Genetics of human and canine dilated cardiomyopathy. *Int J Genomics*. 2015;2015:204823.
17. Abbott JA. Feline hypertrophic cardiomyopathy: an update. *Vet Clin North Am Small Anim Pract*. 2010;40(4):685-700.



**JESSICA MCGINNIS, DVM**, is currently an intern in emergency medicine and critical care with a special focus in cardiology at University of Florida. She earned her DVM from Michigan State University. Following graduation, she completed a 1-year rotating internship at Red Bank Veterinary Hospital. She has a special interest in arrhythmias and arrhythmogenic cardiomyopathy.

**FUN FACT:** When not at work, Jessica enjoys kayaking and river tubing.



**AMARA ESTRADA, DVM, DACVIM (Cardiology)**, is professor of cardiology and associate chair for instruction for the department of small animal clinical sciences, and director of the Teaching Academy at University of Florida. Her research interests include electrophysiology, pacing therapy, complex arrhythmias, cardiac interventional therapy, and cardiac regenerative medicine. She graduated from University of Florida and completed a cardiology residency at Cornell University.

**FUN FACT:** Amara is a licensed Zumba instructor.

# Heartgard® Plus

(ivermectin/pyrantel)

## CHEWABLES

**CAUTION:** Federal (U.S.A.) law restricts this drug to use by or on the order of a licensed veterinarian.

**INDICATIONS:** For use in dogs to prevent canine heartworm disease by eliminating the tissue stage of heartworm larvae (*Dirofilaria immitis*) for a month (30 days) after infection and for the treatment and control of ascarids (*Toxocara canis*, *Toxascaris leonina*) and hookworms (*Ancylostoma caninum*, *Uncinaria stenocephala*, *Ancylostoma braziliense*).

**DOSAGE:** HEARTGARD® Plus (ivermectin/pyrantel) should be administered orally at monthly intervals at the recommended minimum dose level of 6 mcg of ivermectin per kilogram (2.72 mcg/lb) and 5 mg of pyrantel (as pamoate salt) per kg (2.27 mg/lb) of body weight. The recommended dosing schedule for prevention of canine heartworm disease and for the treatment and control of ascarids and hookworms is as follows:

Dog Weight	Cheewables Per Month	Ivermectin Content	Pyrantel Content	Color Coding On Foil Backing and Carton
Up to 25 lb	1	68 mcg	57 mg	Blue
26 to 50 lb	1	136 mcg	114 mg	Green
51 to 100 lb	1	272 mcg	227 mg	Brown

HEARTGARD Plus is recommended for dogs 6 weeks of age and older.

For dogs over 100 lb use the appropriate combination of these chewables.

**ADMINISTRATION:** Remove only one chewable at a time from the foil-backed blister card. Return the card with the remaining chewables to its box to protect the product from light. Because most dogs find HEARTGARD Plus palatable, the product can be offered to the dog by hand. Alternatively, it may be added intact to a small amount of dog food. The chewable should be administered in a manner that encourages the dog to chew, rather than to swallow without chewing. Chewables may be broken into pieces and fed to dogs that normally swallow treats whole.

Care should be taken that the dog consumes the complete dose, and treated animals should be observed for a few minutes after administration to ensure that part of the dose is not lost or rejected. If it is suspected that any of the dose has been lost, redosing is recommended.

HEARTGARD Plus should be given at monthly intervals during the period of the year when mosquitoes (vectors), potentially carrying infective heartworm larvae, are active. The initial dose must be given within a month (30 days) after the dog's first exposure to mosquitoes. The final dose must be given within a month (30 days) after the dog's last exposure to mosquitoes.

When replacing another heartworm preventive product in a heartworm disease preventive program, the first dose of HEARTGARD Plus must be given within a month (30 days) of the last dose of the former medication.

If the interval between doses exceeds a month (30 days), the efficacy of ivermectin can be reduced. Therefore, for optimal performance, the chewable must be given once a month on or about the same day of the month. If treatment is delayed, whether by a few days or many, immediate treatment with HEARTGARD Plus and resumption of the recommended dosing regimen will minimize the opportunity for the development of adult heartworms.

Monthly treatment with HEARTGARD Plus also provides effective treatment and control of ascarids (*T. canis*, *T. leonina*) and hookworms (*A. caninum*, *U. stenocephala*, *A. braziliense*). Clients should be advised of measures to be taken to prevent reinfection with intestinal parasites.

**EFFICACY:** HEARTGARD Plus Chewables, given orally using the recommended dose and regimen, are effective against the tissue larval stage of *D. immitis* for a month (30 days) after infection and, as a result, prevent the development of the adult stage. HEARTGARD Plus Chewables are also effective against canine ascarids (*T. canis*, *T. leonina*) and hookworms (*A. caninum*, *U. stenocephala*, *A. braziliense*).

**ACCEPTABILITY:** In acceptability and field trials, HEARTGARD Plus was shown to be an acceptable oral dosage form that was consumed at first offering by the majority of dogs.

**PRECAUTIONS:** All dogs should be tested for existing heartworm infection before starting treatment with HEARTGARD Plus which is not effective against adult *D. immitis*. Infected dogs must be treated to remove adult heartworms and microfilariae before initiating a program with HEARTGARD Plus.

While some microfilariae may be killed by the ivermectin in HEARTGARD Plus at the recommended dose level, HEARTGARD Plus is not effective for microfilariae clearance. A mild hypersensitivity-type reaction, presumably due to dead or dying microfilariae and particularly involving a transient diarrhea, has been observed in clinical trials with ivermectin alone after treatment of some dogs that have circulating microfilariae.

**Keep this and all drugs out of the reach of children.**

In case of ingestion by humans, clients should be advised to contact a physician immediately. Physicians may contact a Poison Control Center for advice concerning cases of ingestion by humans.

Store between 68°F - 77°F (20°C - 25°C). Excursions between 59°F - 86°F (15°C - 30°C) are permitted. Protect product from light.

**ADVERSE REACTIONS:** In clinical field trials with HEARTGARD Plus, vomiting or diarrhea within 24 hours of dosing was rarely observed (1.1% of administered doses). The following adverse reactions have been reported following the use of HEARTGARD: Depression/lethargy, vomiting, anorexia, diarrhea, mydriasis, ataxia, staggering, convulsions and hypersalivation.

**SAFETY:** HEARTGARD Plus has been shown to be bioequivalent to HEARTGARD, with respect to the bioavailability of ivermectin. The dose regimens of HEARTGARD Plus and HEARTGARD are the same with regard to ivermectin (6 mcg/kg). Studies with ivermectin indicate that certain dogs of the Collie breed are more sensitive to the effects of ivermectin administered at elevated dose levels (more than 16 times the target use level) than dogs of other breeds. At elevated doses, sensitive dogs showed adverse reactions which included mydriasis, depression, ataxia, tremors, drooling, paresis, recumbency, excitability, stupor, coma and death. HEARTGARD demonstrated no signs of toxicity at 10 times the recommended dose (60 mcg/kg) in sensitive Collies. Results of these trials and bioequivalency studies, support the safety of HEARTGARD products in dogs, including Collies, when used as recommended.

HEARTGARD Plus has shown a wide margin of safety at the recommended dose level in dogs, including pregnant or breeding bitches, stud dogs and puppies aged 6 or more weeks. In clinical trials, many commonly used flea collars, dips, shampoos, anthelmintics, antibiotics, vaccines and steroid preparations have been administered with HEARTGARD Plus in a heartworm disease prevention program.

In one trial, where some pups had parvovirus, there was a marginal reduction in efficacy against intestinal nematodes, possibly due to a change in intestinal transit time.

**HOW SUPPLIED:** HEARTGARD Plus is available in three dosage strengths (See DOSAGE section) for dogs of different weights. Each strength comes in convenient cartons of 6 and 12 chewables.

For customer service, please contact Merial at 1-888-637-4251.



©HEARTGARD and the Dog & Hand logo are registered trademarks of Merial.  
©2015 Merial, Inc., Duluth, GA. All rights reserved. HGD16TRADEAD (01/18).