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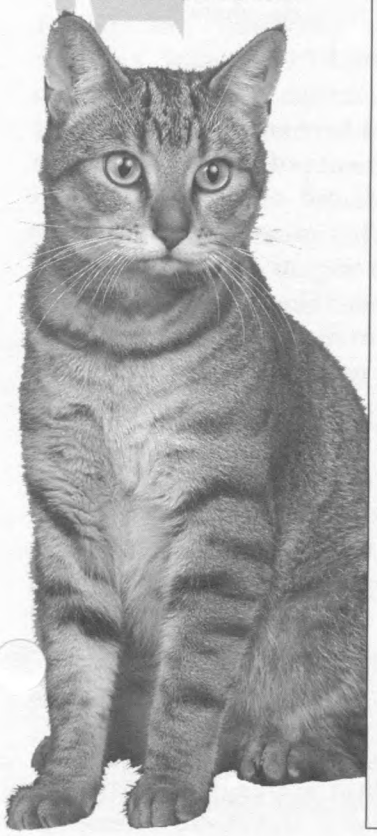

Management of Heart Failure: Neurohumoral Modulation, Diuretics, and Salt Restriction

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Our understanding of the pathogenesis and management of heart failure has markedly changed over the last 20 years. During this time we have learned that the heart may fail due to diastolic dysfunction as well as to systolic dysfunction; that hemodynamic alterations and their managment are less important than the body's own maladaptive neurohormonal response to a fall in cardiac output; that drugs which improve hemodynamics may actually result in long-term harm; and that the greatest clinical benefits result from therapies which blunt the body's neurohormonal response in heart failure. In addition, there have been a plethora of new procedures, drugs, and even drug classes introduced for the management of cardiac disease.

Some of the most important clinical ramifications of heart failure, such as dyspnea (due to pulmonary edema or pleural effusion) and ascites, are directly attributable to sodium and fluid retention resulting from activation of the renin-angiotensin-aldosterone system (RAAS). Management of the signs of congestive heart failure (CHF) has relied upon the use of natriuretic diuretics (furosemide), restriction of dietary sodium, and more recently angiotensin converting-enzyme inhibitors (ACE-I) which, by blocking aldosterone production, combat sodium retention and congestion. In addition, as vasodilators, ACE-I unload the heart and improve cardiac output and exercise, normalize electrolyte aberrations, and blunt the pathological cardiovascular remodeling produced by angiotensin II and aldosterone.

While off-loading therapy with the aforementioned drug groups can be life-saving, their use can be associated with adverse side-effects. Most notable of these are hypotension, azotemia, renal failure, and arrhythmias. Certain complications are more apt to occur when combinations of drugs are used. Because of the potential for such side effects, these drugs are best employed in specific sequence and combinations. The following discussion relates to their use in the management of **chronic** heart failure.

Angiotensin Converting-Enzyme Inhibitors

In landmark veterinary studies of enalapril in New York Heart Association (NYHA) phase III and IV heart disease (moderate to severe heart failure) due to mitral regurgitation (MR) and dilated cardiomyopathy (DCM), enalapril improved survival by >100 percent, reduced pulmonary edema, and improved quality of life scores in dogs. Exercise capacity also improved in dogs with experimental mitral insufficiency. Benazepril has likewise been shown to improve survival. ACE-I have proven to

provide additional benefits in human patients by blocking pathological remodeling, presumably slowing progression of heart disease, and by normalizing serum electrolyte concentrations. Today, ACE-I represent the cornerstone in the chronic management of CHF. They are indicated in virtually all cases of systolic heart failure in which they are tolerated.

There was early concern regarding the renal safety of these compounds. All ACE-I which have enjoyed extensive clinical use have been associated with renal dysfunction, usually temporary. There has been speculation that, at very high doses (180x the clinical dosage), ACE-I have direct nephrotoxic effects. It is generally felt that the major impact of ACE-I on the kidney, with clinically relevant dosages, is through production of hypotension with reduced renal perfusion pressure and worsening of azotemia. To date, veterinary clinicians have had experience with enalapril, captopril, benazepril, and lisinopril. Of these, only enalapril has been extensively studied and is licensed for use in management of heart failure in the United States, although benazepril has been marketed in Europe and Canada. The active metabolite of benazepril is reportedly excreted both in the bile and in the urine so that lower serum concentrations are evident in experimental renal disease. The clinical relevance of this is unclear. Over 15 years of veterinary clinical experience with ACE-I (mainly captopril and enalapril) have taught us that their impact on kidney function is minimal even in the face of severe heart failure. When azotemia is observed, ACE-I are almost always used in conjunction with diuretics and sodium restriction, and hypotension results. Typically, cessation of diuretic therapy or reduction in the dosage results in the reversal of azotemia.

In studies of enalapril in moderate to severe heart failure due to MR and DCM, there was actually a lower incidence of azotemia in the enalapril-treated group than the placebo-treated group. Furthermore, a study of enalapril's role in the delay or prevention of heart failure due to naturally-occuring MR showed that the standard dosage of 0.5 mg/kg daily had no effect on serum creatinine concentrations, as compared to placebo.

Evidence is building to demonstrate benefit when ACE-I are administered chronically to both human and veterinary patients with naturally-occurring and experimental renal failure. Mechanisms for this improvement are postulated to be the antihypertensive effect, reduction of angiotensin II-induced mesangial cell proliferation, and renal vasodilatory effects of ACE-I, the latter related to a fall in renal filtration pressure and proteinuria. Enalapril has recently been shown to reduce urine protein loss and reduce blood pressure in naturally-occurring canine glomerulonephritis. Likewise, benazepril reduced azotemia and proteinuria in a short-term study of experimental and naturally-occurring renal insufficiency in cats, and lowered BUN and creatinine concentrations and blood pressure in cats with polycystic kidney disease.

As mentioned above, ACE-I have the potential to produce symptomatic hypotension. This is due to the mixed vasodilatory effect of this group of drugs, and is typically observed when ACE-I are used in conjunction with other off-loading therapies such as vasodilators, diuretics, and sodium restriction. Hypotension is reversed by altering drug therapies, but may be problematic in producing azotemia, inappetence, weakness, lassitude, and precipitating digitalis intoxication by reducing renal elimination.

Beta-Blockers

Beta-blockers, such as metoprolol and carvedilol have earned a place in the management of heart failure in human dilated cardiomyopathy, and atenolol has gained wide-spread use in HCM in cats. The rationale for using beta-blockers in DCM is derived from the large body of evidence as to the harmful nature of the sympathetic nervous system (SNS) in the syndrome of CHF. Their use has been slow to be accepted because of their negative inotropic effect and difficulties in titrating an effective dose. Nevertheless, improved quality of life, exercise tolerance, and survival have all been experienced in multiple clinical trials with carvedilol and metoprolol. Carvedilol, a non-selective beta- and alpha-blocker, also has oxygen radical scavenging capabilities and reduces endothelin release. In

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addition to sparing the heart of the effects of the SNS, the drug serves as a vasodilator and antioxidant, reduces heart rate, and has antiarrhythmic properties. Carvedilol has two major drawbacks. First, it is a negative inotrope so it is difficult to use with severely symptomatic patients. Second, it is expensive. Atenolol is less expensive but comes in larger milligram tablets.

Aldosterone Receptor Blockers

Spironolactone and eplerinone, both aldosterone receptor blockers used in the treatment of heart failure in humans, are thought to be effective by blocking the remodeling effects of aldosterone. It has been shown in people, but not cats, that aldosterone and angiotensin II "escape" from ACE-inhibitor suppression weeks to months after institution of therapy. Spironolactone has been embraced by veterinary cardiologists for the treatment of CHF caused by dilated cardiomyopathy, mitral regurgitation, etc. in dogs. Unpublished studies by Rausch and colleagues at North Carolina State University (NCSU) demonstrated no risk for hyperkalemia in dogs treated concurrently with enalapril and spironolactone. The dosage used by this author for aldosterone receptor blockade is 0.5 mg/kg QD. The use of spironolactone as a diuretic is discussed below.

Sodium Restriction

The salt avidity that results from aldosterone secretion in heart failure has been well documented. Sodium retention contributes to signs of congestion (pulmonary edema, ascites, pleural effusion) and hence reduction in salt intake is logical. There are little data on clinical outcomes with such strategy, but stringent salt restriction with diuresis has been shown to reduce total body sodium stores while, paradoxically, blunting acute furosemide-induced diuresis. Roudebush demonstrated that neither moderate nor severe salt restriction alone caused azotemia in aged, normal dogs, but when furosemide (3.2 mg/kg b.i.d.) was coupled with severe (but not moderate) salt restriction, serum creatinine rose by 63 percent - more than twice as much as in dogs receiving a diet with a standard sodium content. Furthermore, both moderate and severe salt restriction activated the renin-angiotensin-aldosterone system (RAAS) and when furosemide was added to the regimen, there was nearly a 6000-fold increase in serum aldosterone concentration with severe salt restriction. Finally, it is well established that salt restriction increases the likelihood of azotemia with ACE-I therapy.

One can conclude that sodium restriction, while logical and likely useful in reducing total body sodium concentration and diuretic requirements, is not without a toll. This toll represents the tendency to increase azotemia with concurrent diuretic and ACE-I therapy and to activate the RAAS. Use of moderate salt restriction (e.g., a diet designed for renal patients with .22 percent sodium by dry weight) early in heart failure is advisable, with severe salt restriction (.10 percent sodium by dry weight) being reserved for patients refractory to therapy. Concurrent diuresis should be avoided as long as possible and ACE-I should accompany sodium restriction and diuretic therapy.

Diuretics

The most widely used diuretic is furosemide, a loop diuretic. It is potent and, while life-saving, it has the potential to produce azotemia, hypotension, and electrolyte disturbances; to lower cardiac output; and to activate the RAAS. Fatal arrhythmias have been associated with "non-potassium sparing diuretics." Furosemide is not primarily nephrotoxic, though it can potentiate other nephrotoxic drugs. It produces prerenal azotemia by dehydration and hypotension and has a synergistic effect in diminishing renal function when used with either ACE-I or sodium restriction.

Furosemide is the drug of choice for life-threatening pulmonary edema. Otherwise, it should be used only as needed to control signs of congestion. In other words, because it activates the RAAS, lowers blood pressure and cardiac output, causes azotemia and electrolyte disturbances, and potentiates adverse effects of other cardiac therapies, it should not be used as a monotherapy. With the exception of emergency therapy, furosemide therapy should always be accompanied by an ACE-I and should be used at the lowest dosage compatible with good quality of life. If azotemia develops in a patient receiving poly-pharmacy, the first change should be to decrease the dose of furosemide or cease using it altogether.

The aldosterone antagonist, spironolactone, has received renewed interest with a report that survival was prolonged in humans with heart failure when spironolactone (~0.3 mg/kg QD) was administered concurrently with conventional therapy in NYHA phase IV patients. Because spironolactone is a weak diuretic, particularly at the modest dosage used in this study, the investigators concluded that benefits were due to blunting the adverse effects of aldosterone. This drug might logically be used early in heart failure for this reason, but there are no data for early or pre-heart failure states. As mentioned above, we have seen no increase in electrolyte abnormalities with concurrent ACE-inhibition and adlosterone blockade. It is meant to compensate for temporary or incomplete suppression of aldosterone secretion by ACE-I and should be used concurrently with ACE-I. It is also employed as an adjunctive diuretic at one-two mg/kg QD-BID with a loop diuretic such as furosemide. Enhanced diuresis is enjoyed when two diuretics work synergistically in different parts of the nephron.

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The 2004 American Association of Feline Practitioners' Position Statement on Free-Roaming Abandoned and Feral Cats

The American Association of Feline Practitioners (AAFP) encourages and supports actions to provide solutions to the problems associated with free-roaming abandoned and feral cats. These problems include quality of life issues for the cats themselves, their impact on wildlife, and their potential impact on public health.

It is estimated that the number of free-roaming abandoned and feral cats in the United States may be as high as that of owned cats (about 73 million in 2000). Given the high rate of sterilization among owned cats, these unowned cats are the primary source of cat overpopulation. Animal shelters nationwide receive several million unwanted cats each year. Due to a shortage of available homes, approximately 75 percent of these cats are euthanized.

The impact of both owned and unowned free-roaming cats upon the environment is an ongoing subject of debate. Even well-fed cats will hunt and kill prey. These predations cause a significant—and preventable—loss of birds, small mammals, reptiles, and amphibians.

Both owned and unowned free-roaming cats pose small but important threats to human health. Zoonotic agents include rabies virus, *Toxoplasma gondii, Bartonella* spp., *Toxocara cati, Microsporum canis, Cryptosporidium* spp., *Campylobacter* spp., *Yersina pestis, Cheyletiella* spp., and *Francisella tularensis.* (A comprehensive summary can be found in the *American Association of Feline Practitioners 2003 Report on Feline Zoonoses.*) Also, human injury can occur if feral cats are handled without proper precautions or experience. If reportable zoonotic diseases are diagnosed, appropriate health officials must be notified.

Surveys indicate that seven to 22 percent of U.S. households feed unowned cats, thus increasing their numbers. Few of these cats have been neutered. Public policies for addressing the free-roaming abandoned and feral cat situation should take into account the lack of public awareness about the seriousness of the problem, the bonding of caretakers to unowned cats, and the growing societal opposition to euthanasia. The veterinary profession can play an important role in preventing abandonment, and in providing education about feral cat issues.

I. Education

A. The AAFP encourages public education campaigns designed to reduce domestic cat abandonment.

B. Massive public education campaigns to prevent abandonment will require committed cooperation between state and local government agencies, wildlife organizations, humane associations, and veterinary associations.

C. Education to prevent abandonment should encourage responsible pet ownership, including the importance of early spaying and neutering, keeping cats indoors, preventing or solving behavior problems, and consulting with veterinarians for information on these issues.

D. Public education campaigns should also address the consequences of feeding feral cats, humane solutions (including spaying and neutering) to cat overpopulation, and contact information for groups that can provide assistance.

E. Veterinary and technician schools should emphasize the prevention and/or solution of behavior problems and other factors leading to cat abandonment. Feral cat issues should be addressed, with programs in place to help reduce the feral cat population.

II. The Role of Veterinary Professionals

A. Client education is essential to the prevention and/or solution of behavior problems—the primary cause of pet cat abandonment and relinquishment to animal shelters. Veterinary professionals, including educated staff members, can help clients understand:

1. The expenses, time, and other factors involved in responsible cat ownership.
2. What constitutes normal cat behavior, and how to prevent or solve behavior problems.
3. How to provide environmental enrichment for indoor cats, including playtime, outdoor enclosures, and walking cats on harnesses and leashes.
4. How to properly socialize cats.
5. The importance of spaying or neutering cats.

B. When obtaining a history, it is important to ask about any behavioral concerns. In addition, clients can be offered information on the problems associated with unowned cats, and how they can be part of the solution.

III. Public Policy

A. The AAFP strongly supports reducing the numbers of unowned free-roaming abandoned and feral cats through humane capture (with placement in homes where appropriate) by local health departments, humane societies, and animal control agencies. All free-roaming abandoned and feral cats that are not in managed colonies should be removed from their environment and treated in accordance with local and state ordinances.

B. State and local agencies are encouraged to promote public policies that:

1. Require rabies vaccination of all cats, according to the recommendations of the Compendium of Animal Rabies and Control.
2. Require mandatory sterilization of all cats adopted from humane organizations and animal control agencies.

3. Promote sterilization of privately owned cats prior to sale or adoption if they are not intended for breeding.
4. Encourage microchip identification of all pet cats, and the development of an international universal microchip reader.
5. Encourage keeping owned cats indoors, in an outdoor enclosure, or on an attended leash.
6. Prevent the establishment of managed cat colonies in areas where cats pose a threat to protected wildlife.

IV. Managed Cat Colonies

A. The AAFP supports appropriately managed cat colonies. Humane alternatives to the destruction of healthy cats for animal control purposes should be actively pursued by veterinary, humane, and wildlife organizations. Such alternatives include increased sterilization and humane education.

B. The goal of colony management should be the eventual reduction of the colony through attrition; managed colonies are an interim solution to the problem of free-roaming abandoned and feral cats.

C. The AAFP opposes placement of managed cat colonies on public lands (except in lawfully permitted areas), in areas where at-risk wildlife could be threatened, or in areas where they may pose a significant zoonotic risk to the public.

D. A model feral cat program should include the following elements:
   1. The goal should be to continually reduce the cat population; however, eliminating the colony may not be achievable due to the immigration of new cats, including the relocation of feral cats from other colonies.
   2. The colony should be located in an area where the cats do not pose a threat to protected wildlife. The location of the colony should be inconspicuous so as not to encourage abandonment of pet cats. The area should be kept clean, and food left for the cats should be consumed by dark so as not to attract pests and wildlife.
   3. The colony must comply with local ordinances, and landowner permission must be obtained.
   4. A monitoring program should be in place to identify new cats joining the colony, as well as cats requiring medical attention. Identification and medical history records should be kept for all cats.
   5. Ideally, all cats within the colony should be humanely captured in order to receive the following treatments:
      a. Health examination
      b. Sterilization
      c. Rabies vaccination
      d. Vaccination against feline panleukopenia, feline herpesvirus, and calicivirus.
      e. Identification by ear-tipping
      f. Testing for feline leukemia virus and feline immunodeficiency virus.
      g. Adoption of kittens and socialized adult cats if homes are available.
      h. Return or removal from the colony of cats that cannot be adopted.
   6. In order to meet the primary objective of reducing cat populations over the long term, programs should be organized to perform the largest number of sterilizations possible. As in other "herd health" situations, services can be prioritized when resources are limited. The largest feral cat programs offer only sterilization, ear-tipping, and rabies vaccinations on the premise that effective cat control will also reduce the transmission of infectious diseases.

E. In order to minimize zoonotic disease transmission, the AAFP recommends:
   1. Immunocompromised and splenectomized persons should not be involved in these programs.
   2. Program workers should have the knowledge and equipment (i.e., exam gloves, masks, and protective eyewear) needed for handling feral cats when necessary. Most cats in managed colonies require little or no handling,

V. Research

A. The AAFP encourages research into the production of an environmentally safe, effective, non-surgical contraceptive for cats.

B. The AAFP encourages research that better quantifies the impact of free-roaming cats on human health and the natural environment.

C. The AAFP encourages research into the causes of animal abandonment by the public.

VI. Conclusion

Permanent, enduring solutions to the problem of free-roaming abandoned and feral cats will be achievable when:

A. State and local governments provide significantly increased funding to animal control agencies.

B. An environmentally safe and effective non-surgical contraceptive is developed.

C. A massive public education campaign concerning the problems and solutions associated with unowned cats is initiated and sustained.

D. Humane, veterinary, wildlife, and public health organizations all work cooperatively toward common solutions.

Research Briefs

A snapshot of recent feline research from the world's scientific literature

Guptill, L.; Wu, C.C.; Hogenesch, H.; Stater, L.N.; Glickman, N.; Dunham, A.; Syme, H.; Glickman, L. ***"Prevalence, risk factors, and genetic diversity of Bartonella henselae infections in pet cats in four regions of the United States."*** *J. Clin. Microbiol. 2004, 42(2): 652-659.*

Blood was collected from a convenience sample of 271 pet cats aged three months to two years (mean age, eight months, median and mode, six months) between May 1997 and September 1998 in four areas of the United States (southern California, Florida, metropolitan Chicago, and metropolitan Washington, D.C.). Sixty-five (24 percent) cats had *Bartonella henselae* bacteremia, and 138 (51 percent) cats were seropositive for *B. henselae*. Regional prevalences for bacteremia and seropositivity were highest in Florida (33 percent and 67 percent, respectively) and California (28 percent and 62 percent, respectively) and lowest in the Washington, D.C. (12 percent and 28 percent, respectively) and Chicago (six percent and 12 percent, respectively) areas. No cats bacteremic with *B. clarridgeiae* were found. The 16S rRNA type was determined for 49 *B. henselae* isolates. Fourteen of 49 cats (28.6 percent) were infected with 16S rRNA type I, 32 (65.3 percent) with 16S rRNA type II, and three (6.1 percent) were coinfected with 16S rRNA types I and II. Flea infestation was a significant risk factor for *B. henselae* bacteremia (odds ratio = 2.82, 95 percent confidence interval, 1.1 to 7.3). Cats greater than or equal to 13 months old were significantly less likely to be bacteremic than cats less than or equal to six months old (OR = 0.18, 95 percent confidence interval, 0.05 to 0.61). Flea infestation, adoption from a shelter or as a stray cat, hunting, and being from Florida or California were significant risk factors for *B. henselae* seropositivity. DNA fingerprint was significantly associated with region (P = 0.03) and indoor/outdoor status of cats (P = 0.03).

Pedersen, N.C.; Sato, R.; Foley, J.E.; Poland, A.M. ***"Common virus infections in cats, before and after being placed in shelters, with emphasis on feline enteric coronavirus."*** *J. Feline Med. Surg. 2004, 6(2): 83-88.*

The purpose of this study was to determine the origin and subsequent spread of feline calicivirus (FCV), feline herpesvirus (FHV), and feline enteric coronavirus (FECV) in cats relinquished to shelters. FCV was isolated from the oral fauces of 11 percent of healthy cats upon entry, and isolation rates were highest for kittens (33 percent). FHV shedding was very low (four percent) at the time of entry and occurred mainly in juveniles. FECV shedding was also common among newly relinquished cats (33 percent), especially older kittens and juveniles (90 percent). The subsequent spread of all three viruses was rapid and efficient in the shelter environment. Fifteen percent of cats were shedding FCV, 52 percent FHV, and 60 percent FECV after one week. More detailed studies were done with FECV shedding, which could be accurately quantitated. The amounts of FECV shed by infected cats ranged from 10^2 to 10^{16} particles/swab of feces. FECV shedding was several logs higher in young kittens with primary infection than adult cats with primary infections. The mean levels of FECV shedding among adults were the same for primary and chronic infections. Although shelters were not the primary source of these viruses for many relinquished cats, factors intrinsic to the shelter environment were critical in amplifying shedding and spread to susceptible individuals. Extrinsic factors were especially important for the spread of FHV and FECV. FHV shedding rates increased from four percent to 50 percent in one week's time. The speed and magnitude of the increase in FHV shedding suggested that there was reactivation of latent infections as well as acquisition of new infections. FECV shedding increased 10 to 1,000,000 fold in one week among cats that were already infected at entry, and more than one-half of initially negative cats were shedding FECV a week later. Feline calicivirus infection was the least likely to spread in the shelter. The infection rate only increased from 11 to 15 percent in one week.

Cliquet, F.; McElhinney, L.M.; Servat, A.; Boucher, J.M.; Lowings, J.P.; Goddard, T.; Mansfield, K.L.; Fooks, A.R. ***"Development of a qualitative indirect ELISA for the measurement of rabies virus-specific antibodies from vaccinated dogs and cats."*** *J. Virol. Meth. 2004, 117(1): 1-8.*

A protocol suitable for the detection of rabies virus-specific antibodies in serum samples from companion animals using an enzyme linked immunosorbent assay (ELISA) is described. This method has been used successfully for the qualitative assessment of rabies virus-specific antibodies in serum samples from a cohort of vaccinated dogs and cats. In two initial field studies, a variable population of field samples from the Veterinary Laboratories Agency (VLA), United Kingdom was tested. In the first study (n = 1000), the number of false-positive and false-negative results was 11 samples (1.1 percent) and 67 samples (6.7 percent), respectively. In the second study (n = 920), the number of false-positive and false-negative

results was seven samples (0.8 percent) and 52 samples (5.7 percent). In a third study, undertaken at l'Agence Franqaise de Securite Sanitaire des Aliments (AFSSA), Nancy, France (n = 440), one false-positive sample (0.23 percent) and 91 (20.7 percent) false-negative samples were identified. Data generated using this prototype ELISA indicate a strong correlation for specificity when compared to the gold standard fluorescent antibody virus neutralization (FAVN) test. Although the ELISA has a lower sensitivity than the FAVN test, it is a useful tool for rapidly screening serum samples from vaccinated companion animals. Using a cut-off value of 0.6EU/ml, the sensitivity (R = 93 percent from VLA and 79 percent from AFSSA) and specificity (R = 97.3 percent) indices between the ELISA compared favorably with data generated using the FAVN test. The major advantages of the ELISA test are that it is a qualitative tool that can be completed in four hours, does not require the use of live virus and can be performed without the need for specialized laboratory containment. This contrasts with four days using conventional rabies antibody virus neutralization assays. Using the current format, the ELISA assay described would be a valuable screening tool for the detection of rabies antibodies from vaccinated domestic animals in combination with other Office International des Epizooties (OIE) accepted serological tests.

CORNELL FELINE HEALTH CENTER

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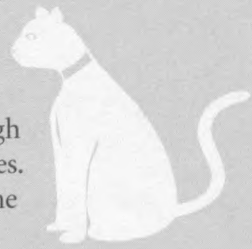
Cornell University, College of Veterinary Medicine

Continuing in the tradition of providing the most up-to-date and relevant information on a broad array of feline health issues, this year's Symposium draws on the knowledge of internationally recognized experts in feline medicine. Speakers from Cornell University, the University of Wisconsin, and the University of Edinburgh in Scotland will provide in-depth learning opportunities. Optional dry labs will give hands-on experience in feline hematology and on-line resources for veterinarians.



The conference will be held in the Veterinary Education Center on the Cornell University campus, and is sponsored in cooperation with Cornell University's College of Veterinary Medicine, the Cornell Feline Health Center, and several corporate sponsors.

Selected Agenda Highlights

Friday, July 30, 2004

- Feline Gastroenterology – Kenneth Simpson, BVM&S, PhD, Dipl. ACVIM, Dipl. ECVIM-CA
- Transdermal Drugs – Lauren Trepanier, DVM, PhD, Dipl. ACVIM, Dipl. ACVCP
- Annual Picnic – Willard Straight Hall, Cornell University Campus

Saturday, July 31, 2004

- Considering the Older Cat – Danielle Gunn-Moore, BVM&S, PhD, MRCVS, RCVS
- Cognitive Dysfunction Syndrome – Danielle Gunn-Moore, BVM&S, PhD, MRCVS, RCVS
- Vaccine Duration of Immunity – David Haworth, DVM, PhD
- Feline Mycobacterial Disease – Danielle Gunn-Moore, BVM&S, PhD, MRCVS, RCVS
- Newly Emerging Infectious Diseases – Danielle Gunn-Moore, BVM&S, PhD, MRCVS, RCVS

Sunday, August, 2004

- Feline Hematology Dry Lab – Tracy Stokol, BVSc, PhD, Dipl. ACVP
- Feline Case Studies in Internal Medicine – Danielle Gunn-Moore, BVM&S, PhD, MRCVS, RCVS
- Electronic Resources – Susanne Whitaker, MLS, AHIP

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Conclusion

Of the therapeutic strategies discussed, loop-diuretic therapy has the greatest potential for adverse side-effects (hypotension, azotemia, activation of RAAS, electrolyte disturbances and fatal arrhythmias). Therefore, except in emergencies, furosemide should not be used as a monotherapy and should be used at the lowest dosage preventing signs of CHF. Salt restriction has similar but lesser effects on RAAS activation, and potentiates diuretic- and ACE-I-induced tendencies toward azotemia. Therefore, moderate, rather than severe salt restriction, is indicated until signs of heart failure become refractory. Of the off-loading therapies discussed, only ACE-I have been shown to benefit heart failure while blunting other pathophysiological processes (RAAS activation, electrolyte abnormalities, aldosterone- and angiotension II-induced cardiac remodeling, and renal dysfunction). Therefore, if either azotemia or hypotension is noted in a patient being managed for heart failure, the diuretic should first be discontinued or the dosage reduced, being reinstituted only as necessary. Reduction or cessation of ACE-I is employed only if altering the diuretic dosage is ineffectual. Though ACE-I are generally safe, BUN and creatinine, as well as serum potassium concentration and systemic blood pressure, should be monitored periodically, particularly if sodium restriction and/or diuretic therapy are utilized concurrently. Finally, when any of these agents are utilized either alone or in combination, there is little risk of significant renal impairment if caution is exercised and hypotension avoided.

Beta-blockers are indicated (with caution) in DCM (NYHA Phase I, II, and III) and in HCM. Aldosterone receptor blockers are useful in CHF, but their exact role is yet to be defined. The author uses spironolactone to aid in RAAS-suppression and to enhance diuresis in refractory CHF.

References

References will be provided upon request.

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