

University of Missouri-Columbia College of Veterinary Medicine and Cooperative Extension Service

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Alumni Profile

A Holistic Approach to Veterinary Medicine

Dr. Wayne Hunthausen (UMC, class of 1979) believes in a holistic approach to veterinary medicine and he is the type of veterinarian to practice what he preaches.

Following graduation, Dr. Hunthausen joined a small animal practice in Kansas City, Missouri. While there he learned one of the harsh realities of veterinary medicine; owners often choose euthanasia when dealing with a healthy animal that misbehaves. This attitude seemed totally inappropriate to Dr. Hunthausen. He felt that his clients deserved an alternative technique for dealing with behavioral problems and he decided to provide them one.

Thus, Dr. Hunthausen began to research the field of animal behavior. He read books and publications on the subject of animal psychology and animal training and attended behavioral seminars. The next time a client complained of an animal's misbehavior he was prepared to help them armed with a behavioral questionnaire of his own design and ready to visit the client's home to study the animal's environment and observe interactions between the owner and the pet.

Over the years Dr. Hunthausen has had many successes in this field and his fame as an animal behaviorist is spreading. Many veterinarians now refer behavioral cases to him, many newspapers, magazines, radio and television stations have interviewed him and Dr. Hunthausen now writes articles on behavioral topics himself.

Dr. Hunthausen's close association with the public and the media has led to his development of a course on pet health care which he teaches each semester at the UMKC community university. He is also planning, along with the Humane Society, to design a pet information booth for the Kansas City Spirit Festival this Fourth of July. Dr. Hunthausen's goal is to acquaint the pet owning public with good health care practices and, hopefully, to increase the public's perception of their pets and of their veterinarians.

Talking about pet care and the quality of the human/animal bond is important, but, for Dr. Hunthausen, just talking about a subject he believes in is never enough. In 1983 he organized a Pet

Partnership Program to, again, practice what he preaches. Through this program, Dr. Hunthausen and volunteers take privately owned animals to visit nursing homes, rehabilitation centers and schools for the handicapped. Dr. Hunthausen's own dog, Russell, is often the center of attention as he performs elaborate tricks at his owner's commands. Requests for visits by Dr. Hunthausen's troupe grow daily and they are now seeking more volunteers.

In the Spring of 1984 Dr. Hunthausen decided to put his holistic brand of veterinary medicine to the true test. He opened his own veterinary practice in Kansas City. He deals with his patient's medical and surgical needs of course, but he also deals with their behavioral needs as well. To give his clients and patients complete care, the old fashioned housecall has become a new fashioned part of his practice. He feels that seeing animals in their own environment minimizes their fears and often helps in determining the basis for many medical and behavioral problems.

As if his time weren't adequately occupied already, Dr. Hunthausen fills any spare moments he can with photography. He is an accomplished amateur photographer whose work has been seen in three exhibitions within the Kansas City area. He specializes in photos of people and pets as one might expect, but he also specializes in the unlikely field of X-Ray printing. His first exhibition of Seashell X-Ray Prints did extremely well.

As one reporter wrote about Dr. Hunthausen, "His approach to both photography and animals is characterized by his sensitivity and deep concern." Dr. Hunthausen is just the type of spokesperson and practitioner that our profession needs.

cover story

Photographer Don Connor captured this tranquil view of the College Equine Center.

On page 6 veterinary student Lillian Roberts describes the research efforts surrounding the not-so-tranquil disease known as Potomac Horse Fever.

Dates To Remember

July 23-26. AVMA Convention, Las Vegas, Nevada. Check your AVMA program for the time and place of your *Alumni Reception*.

October 19. College of Veterinary Medicine Alumni Day featuring the Missouri/Nebraska Football Game. Help us welcome the new coach. — Special announcements will reach you from the Alumni Office.

November 1-3. Annual Fall Convention, Columbia, Missouri. Alumni reunions will be held on November 1 for the Classes of 1950, 1960, 1970 and 1980. All reunion classes will be contacted personally. Social hour will be held for reunion classes, faculty and friends.

Come join us at any or all of these functions. Take the opportunity to tour your College, meet old friends and make some new acquaintances.

IN THIS ISSUE

In Your College	3
Potomac Horse Fever	4-5
Feline Leukemia: A Review	6-7
Cardiac Arrhythmias & Pacemakers	8-10
On The Lighter Side	11
College Mule Team	12

In Your College

Dean's Corner



Faculty Publish

The following have recently been published by members of your College:

St. Omer, V.E.V. and Mohammad, F.K.: "Effects of Antidotal N-Acetylcysteine On the Pharmacokinetics of Acetaminophen In Dogs", *J. Vet. Pharmacol. Therap.*, Vol. 7: 277-281, 1984.

Adams, H.R.: "Pharmacodynamic Actions of Antimicrobial Agents In Host Cell Membranes", *JAVMA*, Vol. 185, #19, 1984.

Adams, H.R.: "New Perspectives In Cardiopulmonary Therapeutics: Receptor-Selective Adrenergic Drugs", *JAVMA*, Vol. 185, #9, 1984.

Miller, R.B. and Fales, W.H.: "Infectious Bovine Keratoconjunctivitis: An Update", *Veterinary Clinics of No. Am.: Large An. Prac.*, Vol. 6, #3: 597-608, 1984.

Youngquist, R.S., Blanchard, T.L., Lapin, D. and Klein, W.: "The Effects of EDTA-TRIS Infusion on the Equine Endometrium", *Theriogenology*, Vol. 22: 593-599, 1984.

Hewitt, W.R. and Brown, E.M.: "Nephrotoxic Interactions Between Ketonic Solvents and Halogenated Aliphatic Chemicals", *Fund. and Appl. Toxic.*, Vol. 4: 902-908, 1984.

Brown, E.M. and Hewitt, W.R.: "Dose-Response Relationships in Ketone-Induced Potentiation of Chloroform Hepato- and Nephrotoxicity", *Toxic. and Appl. Pharm.*, Vol. 77: 437-453, 1984.

Hahn, A.W. and Nichols, M.F.: "A Stable Polarographic Oxygen Electrode", *Proc. Symp. Biosensors*: 44-46, 1984.

Collier, L.L., Prieur, D.J. and King, E.J.: "Ocular Melanin Pigmentation Anomalies in Cats, Cattle, Mink and Mice with Chediak-Higashi Syndrome: Histologic Observations", *Current Eye Res.*, Vol. 3: 1241-1251, 1984.

Engleman, R.W., Collier, L.L., and Marliqve, J.B.: "Unilateral Exophthalmos in *Sebastes sp.*: Histopathologic Lesions", *J. Fish Dis.*, Vol. 7: 467-476, 1984. This publication resulted from Bob Engleman's student Phi Zeta research project.

Last fall's announcement by the AVMA that your College was placed on Limited Accreditation because "funding for the College is marginal and not adequate for long term stability" brought an outpouring of support. Offers of help came from individuals, parents of students, livestock and companion animal groups, major corporations, veterinarians and their spouses, and many others. The leadership of the Missouri Veterinary Medical Association (MVMA) adopted improvement of the College as one of their 1985 priorities. They have been working actively to inform the proper people that the school's needs are real and legitimate. Thank you MVMA.

The budget for professional (DVM), graduate, postdoctoral, extension, and continuing education programs, diagnostic services, patient care, and research approximates \$8.5 million.

Of this, about \$3 million (35%) comes from state appropriations. This puts Missouri among the lowest in the nation. About \$1.5 million (17%) represents tuition and other monies paid to the University. The largest portion, \$4 million (47%), is generated by the College through research grants and contracts, gifts, and fees for patient care and diagnostic services.

The state appropriation is the core budget. It provides stability and the ingredients with which to generate outside funds. State provided essentials are: buildings and facilities; basic equipment; maintenance costs; and salaries for faculty and staff. When these basics are inadequate, the ability to compete for fee income, gifts and grants, contracts and other forms of corporate and government support deteriorates. Thus, when all these people ask how they can help, the answer is "convince public officials that the College is an essential

high priority item for the state." This is easier said than done. The budgetary process is complicated and largely misunderstood. Further, democratic representative government operates in intriguing ways. Realistically, in the words of one legislator, "what actually happens will be what is politically expedient rather than what is right, or best for the state, or the livestock industry, or the veterinary profession or upcoming generations." Thus it becomes the job of your College's many friends to make it politically expedient for Missouri to provide both immediate aid and a long term commitment from the State and the University to support veterinary facilities and programs.

Meanwhile, back on the campus, faculty and staff work to upgrade programs. Minor curricula revisions have occurred and major changes are contemplated. Old standbys are leaving and new faces are appearing. We are stunned by the simultaneous announcement of retirements of Dr. Clarence Bierschwal, Dr. Homer Dale, and Dr. Loren Kintner. These men are legends at Missouri and will never be replaced. Oh yes, new faces will appear and the tradition will go on, but each of these men have left indelible impressions on so many alumni that their impact will be perpetuated.

This fall, Veterinary Alumni Weekend is October 19th, the same day Missouri and new coach Woody Widenhofer take on Nebraska. In addition to the seminar, the educational program provides time for the game and other socializing, including a reception at the Dean's house. Why not join the fun this year?

Also, please plan now for November 2nd to 4th. While the footballers are on the road, housing and dining should be less competitive for the College's 61st Annual Veterinary Conference and Alumni Reunions. This year's scientific speakers are all UMC faculty. Most are newcomers who you'll be pleased to meet and hear. There is also a general session on Estate Planning by an articulate tax attorney, an MVMA membership meeting and many MVMA committee meetings. The Classes of 1950, '60, '70, and '80 have planned reunion dinners on Saturday night, November 2nd, after a reception open to all. A Gala Pig Roast scheduled for Sunday night is included in the registration fee and will feature a chance to meet Coach Widenhofer, possibly the University's new

continued on page 12

Potomac Horse Fever:

A Comprehensive Review

Lillian Roberts (VM3)

Introduction

Potomac Horse Fever, medically known as Acute Equine Diarrhea Syndrome (AEDS), is a specific disease entity of horses and ponies with a spectrum of clinical signs. It was first defined as such in 1982, and on retrospect believed to have first appeared in the summer of 1979 along the Potomac River in Montgomery County, Md. Since that time, intensive research investigations have been carried out in an effort to identify the causative agent or agents. This paper will attempt to summarize the history and epidemiology of the disease, and to highlight the research past and present.

Definition

Potomac Horse Fever is an acute disease entity. The severity of clinical signs ranges from transient fever and slight depression without diarrhea to a severe, explosive diarrhea leading to dehydration, shock, and death in up to 30% of cases. A typical case might proceed as follows:

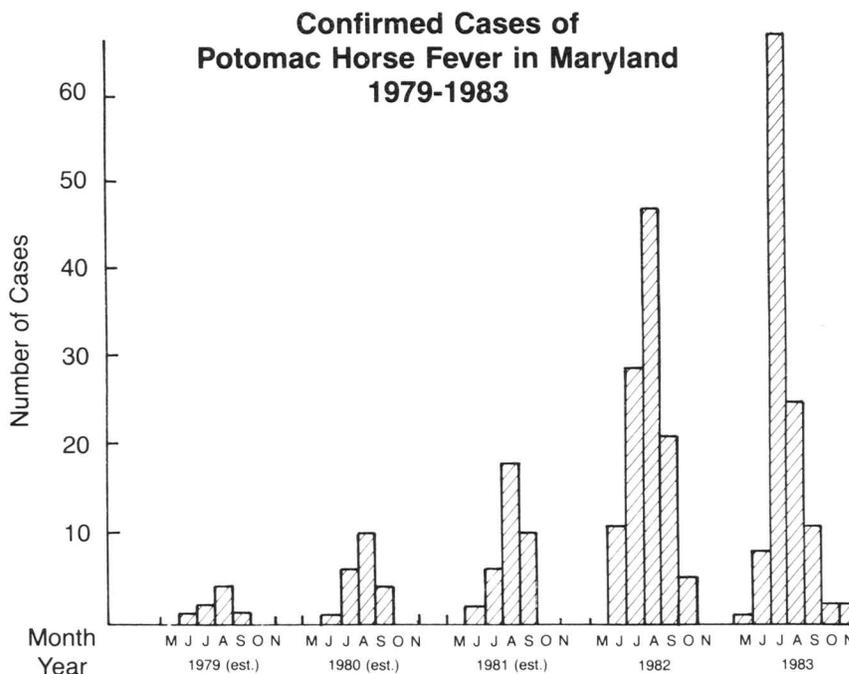
Day 1: Horse is reluctant to eat but does eventually clean up his grain.

Day 2: Horse refuses to eat. The veterinarian is called out and upon examination finds a fever of 103-104°F. (70% of cases). Auscultation of the abdomen reveals few borborygmal sounds, implying ileus early in the course of the disease.

Day 3: The fever remains. Auscultation reveals many high-pitched 'pinging' and 'tinkling' sounds, particularly in the region of the cecum, indicating hypermotility.

Day 3 or 4: A severe, profuse diarrhea develops suddenly and explosively within 28-48 hours after the initial examination. This diarrhea occurs in 80% of all cases and may last from one to ten days and be followed by complete recovery or dehydration and death. In addition, colic of varying severity occurs in 40% of cases, usually associated with a moderately severe diarrhea.

Laminitis is reported in 20-30% of cases, and usually follows the diarrhea



onset by 3 or 4 days. This may be very severe, even leading to sloughing of the hoof, and is often the reason for euthanasia. Hypovolemic shock is another typical cause of death, owing to the severity of the diarrhea. Vesicles and ulcers of the oral mucosa and, more recently, corneal ulceration, have also been noted. In the 70% or so of cases surviving AEDS, recovery is generally complete, with the horse returning to its previous performance level.

Laboratory findings include severe leucopenia (2,000-4,000 cells/mm³) by at least day 2. Packed cell volume ranges from 40 to 65%, reflecting the degree of dehydration present. Plasma protein will be elevated initially, but will rapidly fall to subnormal levels (3-5 mg/ml).

Necropsy discloses an ulcerated stomach, an edematous small intestine, and an inflamed and congested cecum and colon. In addition, severe petechial and ecchymotic hemorrhages are seen along the pulmonary vessels and aorta, and on the endocardium. The lungs are congested and may be consolidated, and the liver is mottled and swollen. On

histologic examination, a necrotizing enterocolitis is observed, especially in the region of the cecum and colon. Vasculitis and microthrombi in the small blood vessels are evidence of disseminated intravascular coagulation, one possible cause of the laminitis. Hemorrhage and architectural disruption of the liver and lymphatic depletion of all lymphatic organs are other findings.

History and Epidemiology

Potomac Horse Fever was first noted in Montgomery County, Md. in 1979. During the summer of that year, at least eight cases of the disease were reported, with two deaths being attributed to it. It seemed to disappear that fall and winter, only to resurface the following summer, when at least twenty cases were recorded. The summer of 1981 saw 36 documented cases, followed by 113 in 1982 and over 150 in 1983. The disease occurs only in the summer and fall, usually peaking in August (see graph I). The overall mortality rate is reported at between 25 and 30%. All known affected states have made AEDS a reportable

disease, and while no quarantine measures are planned, horses are not permitted to travel interstate without current health certification.

In Maryland in 1979, 1980, and 1981, essentially all cases reported were within a mile or two of the Potomac River, along a geographic strip about six miles long, and limited to Montgomery County. In 1982, however, it was noted that, while early cases were along the river, as the summer progressed reports were received from upland Montgomery County, as well as from adjacent regions of Howard and Frederick counties. In addition, reports of a similar syndrome believed to be AEDS were noted in Pennsylvania along the Susquehanna River Valley, and from a race-track in Ohio. Of the 113 confirmed cases, occurring on 51 premises, 28 horses died or were euthanized.

In 1983, the disease followed a course in Maryland similar to that seen in 1982, that is, moving progressively away from the river, with a total of 116 cases and 42 fatalities in that state. Moreover, the disease was now being positively identified in other states, with 32 cases and 10 fatalities recorded in Virginia, and 25 cases with four deaths in Pennsylvania. Additionally, reports of a similar or identical disease, probably AEDS, came from states outside the mid-Atlantic region, including Colorado, Illinois, Indiana, Minnesota, Tennessee, and Texas, and it is now believed that the disease probably occurs nationwide.

Using a lengthy questionnaire distributed to horsemen in the Potomac area, researchers devised a case-control study to determine what factors might increase a horse's risk of contracting the disease. It was learned that there were a few factors that seemed to correlate with risk to at least a slight degree. These are as follows:

- (1) The population was separated into groups of affected, unaffected on affected farms, and unaffected on unaffected farms, for control purposes.
- (2) There is a higher percentage of affected horses in the 7-10 year age group than in the general population.
- (3) A higher proportion of strictly pleasure horses were in the affected group than in the general population.
- (4) The disease tended to reoccur on farms where it had occurred previously, although no correlation was seen with the number of cases that had occurred, nor with the presence

of an affected horse in an adjacent pasture.

- (5) A definite link was noted between incidence of the disease and exposure to other livestock, particularly cattle, and dogs.
- (6) The following factors have shown no difference:
 - Hours spent at pasture
 - Size of pasture
 - Quality or physical description (subjective) of pasture
 - Use of fertilizer or herbicides on the pasture
 - Number of horses using the barn
 - Source or administration of water

In 1983 it was discovered that the clinical disease was transmissible to experimental horses through whole blood transfusions. The experimental cases enabled researchers to better define the disease, and to hazard some tentative conclusions regarding the possible etiology of the syndrome. Using controlled infection models and data from field outbreaks, the following were determined about the mode of transmission:

- (1) The disease is not transmitted easily from horse to horse, indicating that it is probably not contagious.
- (2) The disease is readily transmitted via blood, indicating a probable insect vector and making a point source infection related to ingestion unlikely.
- (3) Serial passages did not diminish the severity of the disease, indicating that the causative agent was infectious rather than toxic in nature.
- (4) Recovered animals are resistant to rechallenge, so a degree of immunity exists.
- (5) A high proportion of the population is susceptible, suggesting that immunity is short-lived or that prevalence is low.
- (6) The agent was hypothesized to be a virus based on these findings.

Research

Meanwhile, in other states, various groups were looking in other directions as part of a coordinated effort between several organizations to find the culprit. From the beginning, researchers had noticed similarities between AEDS and other equine diarrheal diseases, particularly Salmonellosis and the ever-frustrating syndrome of uncertain etiology termed 'Colitis X,' a disease first recognized in 1960. However, fecal cultures were consistently negative for *Salmonella* spp. despite the persistence of sev-

eral laboratories in looking for it. Since the cause of Colitis X has never been positively identified, that disease could not be ruled out. However, other researchers, noting parallels between it and intestinal Clostridiosis in other species, had recently linked Colitis with *Clostridium perfringens* (welchii). However, searches for this organism and/or its toxins were inconclusive, leading researchers to believe that the organism was not involved in the etiology of AEDS, but might in some cases contribute to the spectrum of clinical signs seen. In addition, various isolates of *E. coli* found in field cases were not of any particular strain. In fact, aerobic and anaerobic blood cultures from experimental cases including 789 tests in all produced no significant isolates.

Pursuing a more likely track, several workers were attempting to isolate a virus from fecal and blood samples, with little success. Equine Adenovirus, a previously known orphan virus, was isolated from frozen cultures, but could not be linked to the disease. Another researcher later found coronavirus-like particles in fecal samples, and the unidentified virus looked promising for awhile but apparently turned out to be another dead-end. Virology laboratory work on the blood from experimental cases included 708 tests and yielded no conclusive results.

Initially, serological tests looked no more promising. Sera from experimental and/or field cases were checked for a variety of known pathogens, including *Leptospira*, equine arteritis virus, various herpesviruses, Eastern, Western, and Venezuelan equine encephalitis, *Chlamydia psittici*, and African horse sickness, and no consistent changes in antibody titers were found to any of the organisms.

In conjunction with the other lab tests being carried out, sera from several experimental cases and a few field cases were submitted to Dr. Miodrag Ristic of the College of Veterinary Medicine, University of Illinois, Urbana, Illinois. Considered an expert on Rickettsial diseases in animals, he was sent the samples at the request of Dr. Jean Sessions, a Potomac veterinarian who had observed inclusions reminiscent of *Ehrlichia equi* in neutrophils from a few afflicted horses. Using an indirect fluorescent antibody test (IFA), Dr. Ristic checked the sera for antibodies against *Ehrlichia equi*, *E. canis*, and *E. sennetsu*, a little-known organism

continued on page 11

Feline Leukemia:

By Barry Kipperman (VM3)

Abstract: FeLV is in the news a great deal lately. Veterinary journals, cat magazines and even the national news programs carry information about Norden Laboratory's innovative FeLV vaccine and about the testing procedures used to diagnose the disease. Veterinarians are reading the literature both to educate themselves and to provide specific recommendations to their cat-owning clients.

The latest literature provides many answers, but it also poses some unanswered questions. This review of FeLV will discuss the facts about the disease, the potential public health risks associated with it, the IFA and ELISA testing procedures and Norden's vaccine. It also will outline some points of contention regarding vaccination and testing regimens in order to aid practitioners in making informed decisions.

The feline leukemia virus (FeLV) is a contagious oncogenic RNA virus that induces both neoplastic and non-neoplastic diseases in domestic cats. (Fig. 1) The virus is ubiquitous in geographic distribution, as evidence of infection is found in cat populations throughout the world. It is estimated that at least 50-60% of all cats become infected at some time during their lives. Sick cats are not a major source of exposure to virus since their survival is quite short in duration. It is the apparently healthy, chronically viremic cat that represents the major source of exposure to the virus. (see Figure 2)

Human Health Hazard

FeLV is the only retrovirus to which a substantial number of people are intimately exposed under natural conditions. In 1969 it was discovered that natural field isolates of FeLV could infect and replicate in human cell cultures. This observation plus the finding in 1973 that FeLV is spread contagiously among cats brought concern that FeLV might be able to infect and cause disease in humans.

Since experimental challenge of humans with FeLV can never be done, the potential danger of FeLV to humans can

FeLV Diseases

Neoplastic

- 1) Lymphosarcoma
- 2) Myeloproliferative disorders
 - a) Granulocytic leukemias
 - b) Erythemic myelosis

Non-Neoplastic

- 1) Immunosuppression/Leukopenia
- 2) Aplastic Anemia
- 3) FIP
- 4) Infections
- 5) Glomerulonephritis
- 6) Abortions; stillbirths

Fig. 1—Scope of clinical disease produced by or related to FeLV

Fig. 2—Host-virus relationships in cats infected with FeLV:

100% of cat population		
10% infection rate/year ¹		
Great Majority	Small Minority	Others (?)
1) Immune response-immune for life	1) No immune response	1) Slight exposure
2) No clinical signs	2) Most die within 3.5 yrs:	2) not persistently infected
3) No antigens 4-6 wks. p.i. FeLV(-)	a) 75% from non-neoplastic diseases	3) not immune
4) No viremia; no shedding	b) 25% from neoplastic disease	4) remain susceptible
5) Titers present-SN ² + FOCMA ³	3) 2/3 are FeLV(+) 1/3 are FeLV(-)	
	4) Persistent viremia; shed virus	
	5) No SN titers; some may have titers to FOCMA	
	6) All have FOCMA antigen (neoplasia only)	

¹Virus transmission: Via saliva and nasal secretions only. No fomites, aerosols, or human role in natural transmission, as virus desiccates quickly in environment (2-3 minutes)

²Serum Neutralizing antibodies to gp70 (a viral surface protein) can prevent viremia and neutralize virus; cats still are susceptible to lymphosarcoma because tumor cells may be generated before virus is neutralized.

³FOCMA antibodies are effective in preventing FeLV-induced neoplasia, but do not preclude occurrence of non-neoplastic FeLV-related disease.

FOCMA = Feline Oncovirus Associated Cell Membrane Antigen; a tumor specific antigen found only on the surface of FeLV-induced neoplastic cells.

only be determined by long-term observation of individuals living with infected cats or by examination of human patients with tumors for evidence of FeLV. Given the prevalence of FeLV in the human environment and the scientific awareness of its potential danger, it is surprising how little research has addressed the question of human risk.

There are three types of epidemiological methods that can be used to address this question: (1) retrospective case-control studies; (2) cohort studies; (3) seroepidemiologic studies.

1—In the case control study, persons with and without disease are compared for prior exposure to cats. Most of these studies have evaluated exposure to cats among children with leukemia, yielding

inconclusive results. In one study, a twofold increase in exposure to cats was found in houses where children developed lymphoid cancers compared to those where children developed other forms of cancer. Another study compared cat ownership among more than 500 people with leukemia, lymphoma and sarcoma with over 1000 controls and found no difference.

2—A second approach to evaluate human risk from FeLV is to compare the occurrence of lymphoma and leukemia in highly exposed populations or cohorts (usually veterinarians) to that of unexposed populations. Five studies of the causes of death in veterinarians have been published, with conflicting results.

A Review

In one study of 390 white male Missouri veterinarians, no statistically significant difference in the occurrence of cancer was found compared to controls. However, one worker reported an 80% increase in the occurrence of lymphoid tumors among 19,000 U.S. veterinarians who died after the age of 46 years as compared to physicians and the general U.S. population.

3—Seroepidemiologic or immunologic tests are more definitive methods of determining if FeLV can infect humans. These tests consist of immunologic procedures to determine if FeLV antigens are present in humans exposed to cats or if antibodies to FeLV or to FOCMA are produced by people exposed to infected cats.

Fourteen studies searching for FeLV antigens or antibodies in humans have been published, again yielding conflicting results. In the latest and most complete immunologic analysis of FeLV exposure in humans, cancer patients were tested for FOCMA on the membranes of their tumor cells, for FeLV antigens, and for FeLV and FOCMA antibodies.

In 191 people with various forms of cancer, no evidence of present or past FeLV infection was found. Two patients with acute lymphocytic leukemia who had lived in the same household with FeLV-infected leukemic cats, were repeatedly negative for FeLV antigens and antibodies.

We must be cautious in interpreting this negative data because 10-30% of cats with lymphosarcoma do not have FeLV antigens or FeLV SN or FOCMA antibodies. But, FOCMA is expressed on the cell surface of all FeLV-induced tumors of cats, and this study did not find FOCMA on the tumor cells of any patients; this is the strongest evidence that FeLV was not involved in the etiology of these tumors. Clearly, additional research on the risk of FeLV to humans is warranted.

Recommendations regarding human risk

The observations that FeLV can be shed in large numbers in the saliva of infected cats, that FeLV replicates in human cells and that FeLV-positive cats have a poor prognosis whether healthy or sick, indicates the danger of keeping FeLV-positive cats as pets. The positive cat should be isolated from other cats, children, sick adults and pregnant wom-

en.

To date, no conclusive evidence has been obtained to indicate that the human population is at any increased risk to develop neoplasia as a result of exposure to FeLV-infected cats. Clients should be made aware of information on the public health hazard of FeLV, and be allowed to make their own decision regarding euthanasia of FeLV-positive cats.

Diagnostic Tests

Most recommendations for euthanasia in practice are based on a positive Immunofluorescent Antibody (IFA) test. This test detects FeLV antigens in neutrophils and platelets in peripheral blood. Consequently, one limitation of the test is that antigens may go undetected in the presence of neutropenia and/or thrombocytopenia. Several laboratories that perform the IFA test do not recommend euthanasia of test-positive cats, because transient viremias may exist in nature. These labs advise retesting, and consider only viremias of greater than three months duration to be persistent.

Presently, the company producing the Enzyme Linked Immunosorbent Assay (ELISA) in-hospital test kit for presence of FeLV in serum, does not recommend euthanasia of positive cats. Clearly, it behooves practitioners to know the recommendations of the specific labs performing their FeLV tests.

FeLV vaccine

Vaccine development for FeLV was slow for two major reasons. First, traditional methodologies failed. Modified live and killed virus vaccines were marred by side effects, viral latency, and the possibility of human exposure to FeLV. Second, to demonstrate efficacy, studies were necessarily long-term due to the time needed to demonstrate protection against tumors.

There are two requirements for an effective vaccine: (1) It must protect against viremia and FeLV-associated disease by including gp70, the antigen that stimulates neutralizing antibody; (2) It must include FOCMA to provide protection against neoplastic disease.

In November 1984, Norden Laboratories received a USDA license for 'Leukocell', the first commercial inactivated vaccine against FeLV. The vaccine is composed of soluble viral proteins prepared from a FeLV transformed lymphoid cell line that releases FOCMA and viral antigens. It stimulates neutral-

izing antibodies against the virus and against FOCMA. Thus, the vaccine is a comprehensive immunizing agent.

This vaccine has not been associated with any of the problems that plagued its predecessors. In addition, the vaccine did not enhance tumor development in cats already infected. According to Norden, the vaccine protected 80% of cats against persistent FeLV viremia, and 92% of cats against tumor formation.

Manufacturer recommendations: Give three 1 ml. doses beginning at 9 weeks of age or older, with the first two doses administered two to three weeks apart, and a third booster dose administered two to four months later.

Questions about vaccination and testing

Although recent technological advances provide veterinarians with new and valuable tools by which to prevent and diagnose feline leukemia, they also raise some important questions regarding their use and interpretation.

- 1) *Is it efficacious to vaccinate indoor cats that have minimal exposure to FeLV?*
 - a) Keep in mind that prolonged and intimate contact between infected and susceptible cats is necessary for virus transmission.
- 2) *Is it necessary to test a cat for FeLV disease before vaccination?*

Recommendations:

- a) Norden Labs—Test information is useful but is not a prerequisite for vaccination, as there is no evidence that "Leukocell" will exacerbate FeLV disease.
- b) Veterinary Reference Labs—Vaccinate *after* a negative ELISA test. According to Dr. L. D. McGill at VRL, testing will enable the practitioner to detect cats in the pre-clinical stage of FeLV viremia, reducing the likelihood that a cat harboring a viremia during vaccination will develop signs of FeLV-induced disease shortly after the vaccination regimen is completed.

In forming a testing schedule, the practitioner needs to keep two considerations in mind: (1) The vaccine is not 100% effective in preventing FeLV disease, so a cat that was free of FeLV at the time of vaccination may still develop FeLV-induced disease later in life. (2) 10-30% of FeLV

continued on page 10

STATE OF THE ART:

Cardiac Arrhythmias and Pacemakers

by A.W. Hahn, DVM, PhD

Reprinted with some revisions from the American College of Veterinary Internal Medicine Proceedings of the Second Annual Forum and Twelfth Annual Scientific Program.

Dogs served as the first experimental models for the artificial cardiac pacemakers. However, while the canine species contributed greatly to the development of pacemakers for human use, they have only just begun to benefit from that research.

Since 1958 over 500,000 people have received pacemakers and this number increases by another 150,000 human patients annually. During that same time period probably only about 1000 pacing systems were installed in dogs. Still, we are making progress. More and more veterinarians are now recognizing the value of pacemakers in the treatment of dogs with chronic bradyarrhythmias (slow heart rates) unresponsive to medical therapy.

When it comes to recent pacemaker development in dogs, turnabout seems fair play. The human medical community is now assisting veterinarians in obtaining these pacing systems at a reasonable cost. Pacemakers that have passed their shelflife for human use—but still have an estimated three to five years of working life left—are now available to veterinarians for implantation in their patients. This makes the equipment much more affordable to the clinician and to the pet owner.

Indications for Pacing

The most frequent canine recipient of a pacemaker is 8-15 years of age although some young dogs with congenital conduction defects may also be candidates.

There are three primary conditions in the dog that are best suited to pacemaker therapy: Complete A-V block, Sick sinus syndrome, and Silent atrium. The cardiac electrophysiologic problem is one of either episodic or permanent bradycardia (ventricular rates less than 50/minute). Cardiac output at these rates is usually sufficient to maintain a resting animal, but there is little ability of the circulation to provide increased output during exercise or excitement. In addition

to exercise intolerance, some of these animals present with syncopal attacks (Stokes-Adams Syndrome).

The etiology of these conditions is now always immediately evident. Certainly, Sick Sinus Syndrome is a well recognized entity in Miniature Schnauzers where it is apparently genetic in origin and manifests itself in mid-life. Complete heart block has been seen in many breeds of dogs. Upon later histologic examination, many of these cases have fibrotic lesions in and around the A-V node but some appear to have only a physiological block.

Any animal presenting with bradycardia should undergo an immediate electrocardiographic examination. If any of the above bradyarrhythmias are present, atropine should be used to see if medical therapy can abolish the slow rate. If not, this is a de novo indication for artificial pacemaker therapy.

Anatomy and Physiology of Artificial Pacing Systems

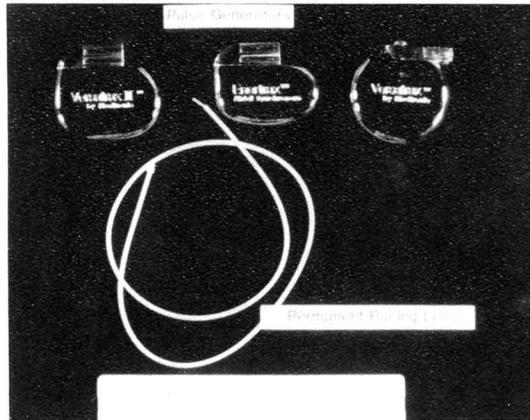
Pacemakers have come a long way since their earliest beginnings. The first implantable pacemaker, developed in the dog and prepared for human use, was a crude device containing only two transistors. Current systems may contain over 15,000 transistors, all on a small (0.1x0.1 inches) silicon chip.

However, even in this age of complex electronics, the same three basic components are still absolutely necessary to make a pacemaker function. These are the myocardial electrode through which a stimulating pulse is delivered to excit-

able tissues, the pulse generator and the power supply.

The essential parameters of the pulse delivered to the myocardium are (1) the pulse repetition rate (i.e. the pulse rate in pulse per minute), (2) the pulse amplitude (in V), and (3) the pulse width (in milliseconds). From parameters (2) and (3), the total energy delivered (in Joules) can be calculated. The pacing pulse should also be "biphasic" so that no net charge is accumulated. This latter feature is important to prevent polarization of the pacing electrode tip and to prevent extra damage to the myocardium. The previously mentioned parameters are crucial to the operation of any pulse generator, regardless of its sophistication. Newer types of pulse generators are now programmable even after implantation. This feature, to be discussed later, gives clinicians a wide choice in patient management.

The myocardial electrode is the device whereby the pulse generator delivers a stimulating change. It may be permanently implanted in either the atrial or ventricular epi myocardium (via thoracotomy) or through transvenous placement, permanently or temporarily placed in contact with the endo-myocardium of the right side of the heart. Clinical experience in the dog has been almost solely devoted to permanent epicardial placement. Experience with transvenous electrode placement in dogs has shown endo and myocardial damage and dislodgement although this is the most commonly used site for pacing in humans. In addition to installation problems, electrode lead wires also have a



finite lifetime. The reliability of both pulse generator and power supply are now superior to the weakest system link—the electrode lead wire.

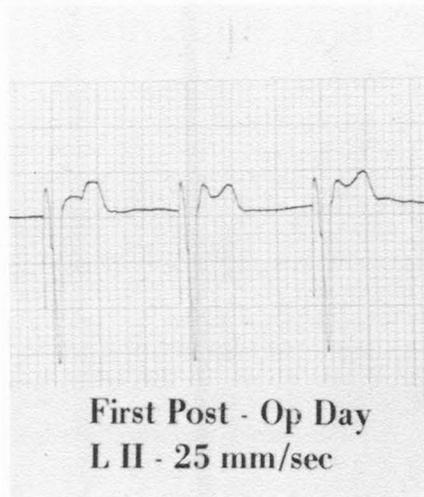
Electrical power to pulse generators was originally furnished by mercury-oxide cells which gave a predicted lifetime of about two years. The introduction of the lithium-iodide cell in the early 1970s has extended this lifetime to eight to ten years. Other novel means of supplying power to pulse generators (i.e. nuclear batteries, biogalvanic energy, piezoelectric power, radio frequency transmitted power, etc.) have all shown their feasibility, yet the lithium-iodide cell remains firmly entrenched in modern pacemaker design.

The type of pacing system just described is known as "ventricular asynchronous" type in that ventricle receives an impulse regardless of any spontaneous activity. Should the ventricle depolarize spontaneously and the artificial pulse come during a relative refractory period, a dangerous, even fatal situation can be created leading to ventricular fibrillation. This very problem was one of the major drawbacks to the early asynchronous pacemakers. In 1964, Berkovitz of American Optical Corporation published on the design of a pacemaker which contained an additional circuit which monitored the electrode tip for a QRS complex. If one was sensed, the pulse generator circuitry was inhibited from firing. It became known as the "demand" pacemaker and resolved the asynchronous problem—in fact, asynchronous pacemakers are simply not used any more.

Manufacturers and users of pacemaker systems have adopted a standard alphabetic code to uniquely identify the type and capabilities of a particular pacemaker. The code uses a five position designation of chamber paced and inhibited, the mode of response, the programmable functions and any special tachyarrhythmia functions available. Table I details the meaning of the code letters.

Thus, a demand pacemaker which stimulates the ventricle and is also inhibited by a spontaneous ventricular impulse would have the designation VVI. If it were also able to be programmed for rate and output but have no special tachyarrhythmia functions, the designation would be VII, PO. Earlier fixed rate, asynchronous pacemakers were designated VOO or AOO.

In 1971, programmability of pacemak-



ers was introduced. Integrated electronic circuits inside the pacemaker were so designed that, with a radio frequency (RF) signal coupled through the skin to an external programmer, the pacing parameters could be changed to suit changing conditions. Many modern devices allow wide flexibility in altering pulse rate, pulse width, sensitivity of response to R or P waves, pulse amplitude, hysteresis (the time differences in escape intervals between sensed and paced beats), refractory period and the pacing mode. Programmable pacers may be placed in the asynchronous mode for short periods of time so that the free-running rate can be determined and thus correlated with battery lifetime. Many models also have a magnetically activated switch which also allows one to check rate and thus battery life.

Installation Procedures

After a decision to install a pacemaker system has been made, the animal is

prepared for a left thoracotomy. Anesthesia must be carefully controlled and monitored. It is also well to have a temporary transvenous lead placed in the right ventricle ready to be attached to an external pulse generator since ventricular rates in these patients often become dangerously low (10/min.) during anesthetic induction. It is comforting to be able to return these rates to a more physiologic level early in the procedure.

After opening of the chest and the pericardium, a "screw-in" epicardial lead is placed in the avascular region of the left ventricle just dorsal to the apex. Newer lead wires do not require suturing to the heart. The flexible lead wire is brought out between the ribs and the pulse generator connected and tested to assure adequate capture. Once capture has been established, the thoracotomy is closed with careful attention to avoid sharp turns in the lead wire.

We have found the placement of the pulse generator under the lattissimus dorsi muscle has been the most satisfactory location. Should the generator require replacement only a small amount of dissection is required and the generator is also available for easy programming. Post-operative care is that of a routine thoracotomy with close attention to electrocardiographic monitoring. Patients with uncomplicated recoveries usually can be released to their owner's care in four to five days.

Recent Developments

As integrated electronic circuits become smaller and more reliable, the field of pacing has become more sophisticated on page 10

Table I

The five position ICHD (Inter-Society Commission for Heart Diseases Resources) code. The first three positions are mandatory.

Position	I	II	III	IV	V
Category	Chamber(s) Paced	Chamber(s) Sensed	Mode of Response(s)	Programmable Functions	Special Functions
Designation	V-Ventricle A-Atrium	V A	T-Triggered I-Inhibited	P-Programmable (Rate and/or output)	B-Burst N-normal rate competition S-Scanning E-External O-none
	D-Double S-Single*	D S* O-none	D-Double O-none R-Reverse, optional	M-Multi- O-none	

*manufacturers designation only

Pacemaker's continued

ticated. Pacemakers are now available not only with programmability, but also with reporting functions built-in. Connected to an external programmer, they can report the percent of paced events, the battery status, parameters being used, patient data and even transmit an intracardiac electrogram.

Some devices may be programmed to sense tachyarrhythmias and respond with high rate bursts of pulses in order to abort potentially serious arrhythmias. In addition, the pendulum has now swung back to "physiologic" pacing which is simply pacing designed to stimulate atrial myocardium and then ventricular myocardium in order to stimulate the natural depolarization process.

With so many modes and alternatives available today, it behooves clinicians entertaining the use of pacemakers as clinical tools to stay up with recent developments in the field. Veterinary clinicians will continue to have access to the low cost purchase of systems for installation. These acquisitions must be done rationally and with our patients and clients best interests as primary focal points.

College Implantation Team

Pacemaker implantation benefits from a cooperative team effort at the College Teaching Hospital. Small animal medicine clinicians; Dr. Dudley McCaw, Dr. Mark Hitt and Dr. Al Jergens, radiologists; Dr. Everett Aronson, Dr. Jimmy Lattimer and Dr. Louis Corwin, anesthesiologists; Dr. Thomas Hurst and Dr. Paul Tamas and small animal surgeons; Dr. John Robertson, Dr. Ron Fallon and Dr. Rodney Straw work closely together on the animal's case while cardiologist, Dr. Al Hahn, serves as a consultant.

Recently the team performed a 5th successful implantation at the College. The patient was a 15 year old male Basenji with third degree heart block unresponsive to medical management. Prior to surgery the Basenji's heart rate was 60 beats per minute. After implantation was complete, the heart rate increased to 101 beats per minute.

—Anyone wishing to refer an animal to the College for a potential pacemaker implantation should contact one of the members of the implantation team.

Pitman-Moore Donates AAHA Autotutorials

Pitman-Moore's senior sales representative, Chip Whitlow, presented the 1984 AAHA Autotutorials to the College. These continuing education programs will be housed in the College Library for viewing by veterinary students and interested veterinarians throughout the state.

Available slide tape programs include:

1. "Surgical Treatment of Lateral Patella Luxation In A Large Breed Dog Demonstrated by Transposition of the Tibial Crest and Trochleaplasty" by Drs. R.L. Leighton and B. Berger, University of California-Davis.
2. "Neurogenic Disorders of Micturition in the Dog and Cat: Part I—Anatomy and Physiology" by Dr. P.M. Moreau, Texas A&M.
3. "Neurogenic Disorders of Micturition in the Dog and Cat: Part II—Diagnosis and Treatment" by Dr. P.M. Moreau.
4. "Nephrotic Syndrome" by Dr. G.M. Kaufman, Purdue University.
5. "Ocular Manifestations of Feline Herpesvirus Infection" by Dr. S.I. Bistner, University of Minnesota.
6. "Paraneoplastic Syndromes" by Drs. G.S. Elliott and R.C. Richardson, Purdue University.
7. "Radiographic Diagnosis of Primary Bone Tumors in the Long Bones of Dogs" by Dr. J.P. Morgan, University of California-Davis.

Available television programs include:

1. "Jejunal Leiomyoma in the Dog: A Case Study" by Drs. G. Theilen, S. Sloan and R. Leighton, University of California-Davis.
2. "Amputation of the Canine Thoracic Limb for Osteosarcoma: A Case Study" by Drs. R. Leighton, G. Theilen and S. Sloan.
3. "Spinal Cord Tumors" by Dr. William Fenner, Ohio State University.
4. "Ophthalmology Techniques: Sections 1-8" by Dr. M. Wyman, Ohio State U.
5. "Ophthalmology Techniques: Sections 9 and 10" by Dr. M. Wyman.
6. "Laboratory Techniques in Veterinary Clinical Immunology" by Dr. O. Barta, Louisiana State University.

Contact Trenton Boyd in the College Library (314/882-2461) if you're interested in viewing the material.

FeLV continued

infected cats will test negative by laboratory diagnostic tests. Clearly, this reduces the reliability of pre-vaccination testing to a certain extent.

- 3) *Should the practitioner stop testing cats for FeLV?*

The answer here relies upon individual evaluations of the degree of protection provided by the vaccine. If the veterinarian has successfully used one or both of the diagnostic tests to monitor for FeLV infection, these programs should most likely be continued.

- 4) *Does the vaccine interfere with laboratory diagnostic tests for FeLV?*

Although the vaccine does contain the major FeLV antigen detected by the IFA and ELISA tests, according to Dr. McGill, the danger of false positives due to the vaccine is virtually eliminated by ten days after vaccination.

- 5) *What are the indications for measuring FeLV antibody titers?*

A FeLV antibody test kit which detects both FOCMA and SN antibodies has recently been licensed by

the USDA. One situation in which determination of antibody titers can be of use to the veterinarian and to the cat owner is the detection of potential virus carriers when introducing new cats into catteries in which there has been no exposure to FeLV.

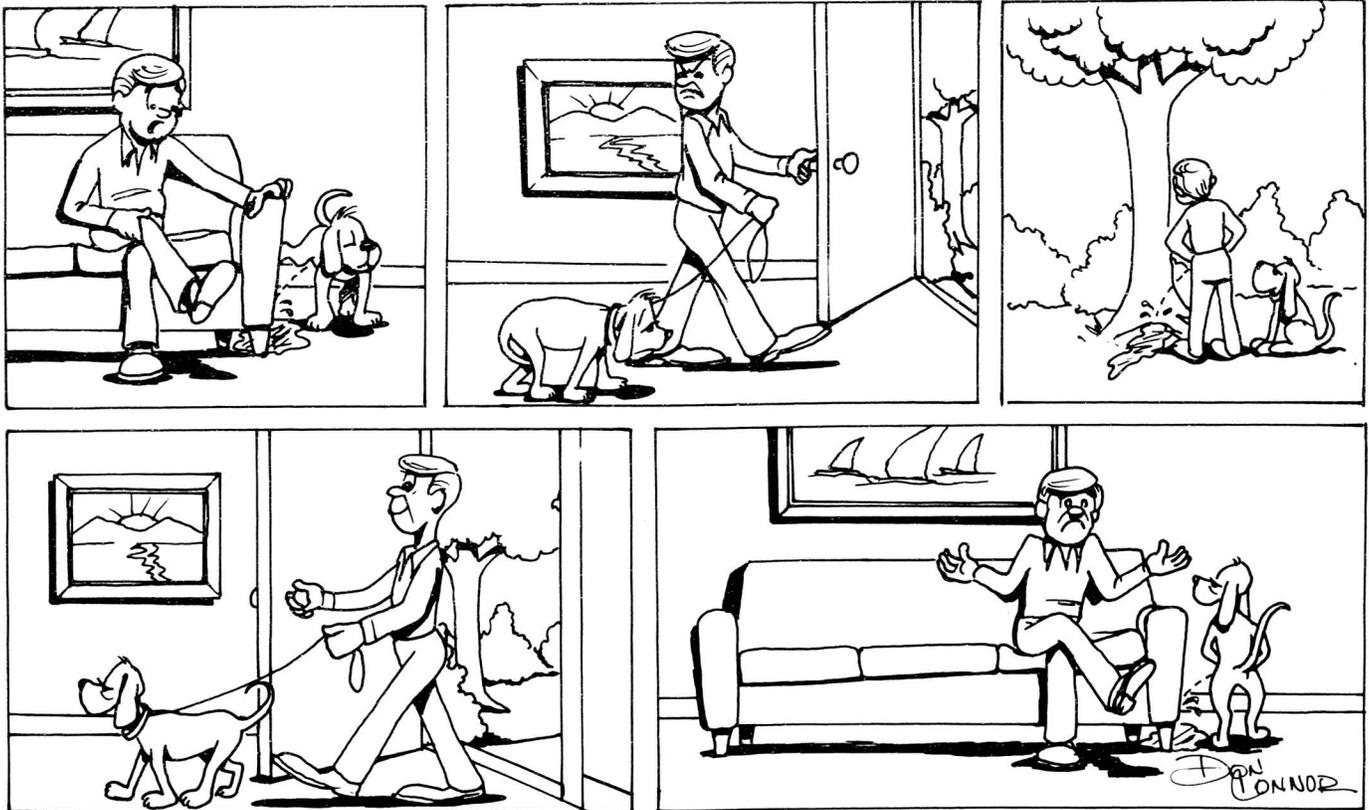
Again, deciphering results here is not unequivocal. For example, does a negative antibody titer represent lack of exposure to FeLV, or instead, persistent viremia in an immunosuppressed cat which will not mount an immune response? The practitioner will most likely need to interpret this test in conjunction with IFA and/or ELISA results to differentiate these possibilities.

Conclusion

Clearly, many unanswered questions need to be resolved before effective and uniform FeLV control procedures can be instituted. Presently, practitioners must keep abreast of the latest information and use it to make compassionate, and informed decisions.

On The Lighter Side:

One Man's Approach To Housebreaking



Potomac Fever continued

believed only to affect humans and never before seen in the United States. The results indicated infection with an agent closely resembling *E. senetsu* in all affected horses, negative in all non-infected animals. In addition, the organism was visualized in the blood macrophages of infected horses. Isolation and further testing revealed that the culprit was not *E. senetsu*, but a hitherto unrecognized species which its discoverers dubbed *Ehrlichia risticii*. The organism passed a major test when it caused clinical signs resembling those of experimental AEDS when inoculated into test horses, and could then be reisolated from them. Furthermore, independent investigators have discovered a rickettsial organism with the characteristics of an Ehrlichia in the intestines of other horses clinically affected with Potomac fever.

When news of the discovery reached epidemiologists working on the problem, they immediately set about searching for possible vectors and reservoirs for

the newly described organism. Ongoing studies of area insect populations were intensified now that researchers had something concrete to look for. Results as of this writing have not been conclusive but all known vectors of rickettsial organisms are ticks, and researchers have been looking in that direction. In addition, serological tests performed on dogs residing on affected farms revealed that they had a significant antibody titer to the organism.

Conclusions

Though more research is needed before Potomac fever can be considered well understood, evidence definitely points to the new *Ehrlichia* as the primary causative agent in the disease, for which the new name equine monocytic ehrlichiosis has been proposed. With current knowledge, researchers should be able to develop a simple diagnostic and/or screening test, hopefully by the time the next season for the natural

disease rolls around this spring. Area workers plan to do a comprehensive survey of all the horses in the affected regions to determine the level of subclinical infection involved. A wildlife and livestock testing program may also be feasible in order to determine which animals serve as reservoirs for the disease. Much remains to be seen, but the cooperation of the various agencies involved in the studies have resulted in a great deal being learned in a very short time. It is left for researchers to discover whether the agent will lend itself to a successful vaccine, or whether classical treatments for other rickettsial diseases will work in this instance. Additionally, it will be interesting to learn just how widespread the problem really is, and whether it has been around longer than anyone imagines, since so many cases of acute severe equine diarrhea go undiagnosed.

References furnished upon request.

College Briefs

College Mule Team



Don Connor, Photo

The September-October issue of the *Missouri Alumnus* magazine featured Hilda and Louise, the College Mule Team, on its cover. The original photograph was taken by Larry Boehm on Francis Quadrangle at the University of Missouri with Jesse Hall and the famous columns in the background. Artist Virginia Blackley then created an oil painting reproduction of the original photograph. (See the black and white copy of the painting to the left.)

The cover photograph and the subsequent painting have become so popular among Missouri alumni and College supporters that the Friends of Veterinary Medicine decided to further reproduce the picture and offer it to interested individuals in two formats. The picture is available first in a limited edition of 20x27 signed and numbered reproductions on fine quality 100% cotton paper and, secondly, in a 18x24 poster form on glossy coated paper. The signed reproductions will cost \$75.00 each plus \$3.00 postage. Posters will be \$5.00 plus \$2.00 postage. To order, please send a check payable to Friends of Veterinary Medicine, P.O. Box 207, Columbia, Missouri. Proceeds will be used to support College programs including the Mule Team.



Dean's Corner continued

President and certainly many old friends.

Please try to come to these events, visit the College whenever you can, support it with words, gifts, patient referrals, and your thoughtful suggestions for improvement. We need you and will do all we can to justify your confidence. Best regards to all.

Robert F. Kahrs, DVM, PhD
Dean

Veterinary Medical Review

College of Veterinary Medicine
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