

SCANNING THE ANIMAL WORLD

By diagnosing thyroid problems, lameness injuries and bone cancer, veterinarians have been finding an increasing demand for nuclear medicine procedures.

AFTER A PARTICULARLY GRUELING workout, a professional sprinter felt a sharp pain radiating up his leg. Although the pain had dulled a bit the next day, he still had trouble walking. It was time for a bone scan to determine if the injury was a stress fracture. Nuclear physician Mark Chambers, DVM, PhD, ushered in his patient—a horse.

Veterinary nuclear medicine is a growing field and over the past few years, it has begun to move beyond the research arena into wide scale clinical application. More and more veterinarians are performing bone scans on lame race horses, iodine treatments on hyperthyroid cats and lung scans to assess

pulmonary thromboembolism in dogs. "Ten years ago, gamma cameras dedicated to veterinary nuclear imaging could only be found in vet colleges," said Clifford R. Berry, DVM, an assistant professor of veterinary radiology at North Carolina State University (NCSU) College of Veterinary Medicine. "Now private vet clinics are beginning to acquire gamma cameras." The proof is in the numbers:

As little as 10 years ago, there were only 8 to 10 imaging cameras available, each within a vet college. Now there are 40 gamma cameras dedicated to animal imaging



Mark Chambers, DVM, PhD, at the University of Illinois College of Veterinary Medicine



The image (left) is a nondisplaced stress fracture of the right tibia from the horse above.

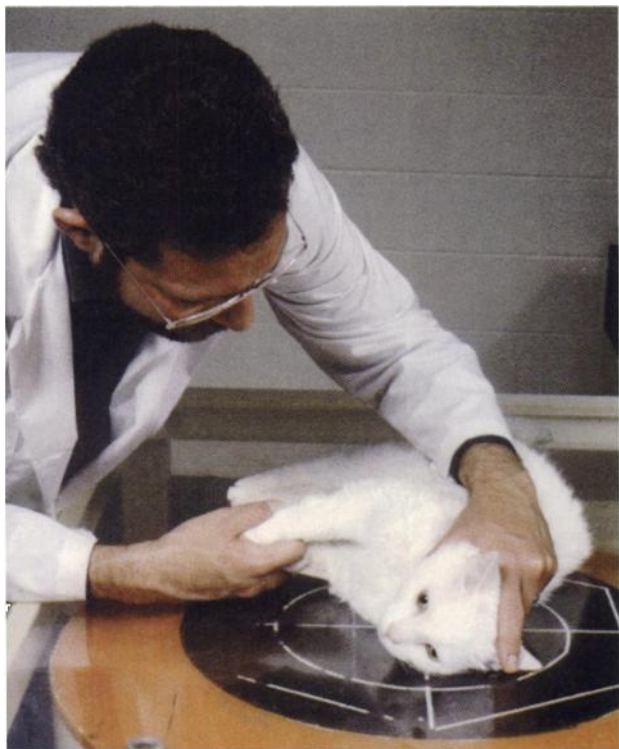
as more veterinary practices begin to perform nuclear medicine procedures.

A Sure Bet at the Track

Although much smaller in scope than traditional nuclear medicine, veterinary nuclear medicine is filling an interesting niche. For instance, bone scintigraphy is becoming a popular tool to diagnose injuries in race horses since it can diagnose hairline fractures two weeks earlier than a traditional radiograph. Wanting to protect their several-hundred-thousand dollar investments, horse owners are willing to pay an average of \$500 to get an earlier diagnosis. Chambers, an assistant professor of veterinary biosciences at the University of Illinois College of Veterinary Medicine and president of the Society of Veterinary Nuclear Medicine, performs bone scintigraphy on about 300 horses per year to evaluate lameness injuries. His caseload primarily consists of performance horses that were referred from veterinarians at race tracks in the Midwest.

To perform the scan, Chambers uses a standard gantry camera positioned either on the ground to image the horse's lower limb areas or on a hoist above the horse's back to image the spine and upper parts of the limb. Veterinarians use the same radio-

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Animal Scans

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pharmaceuticals for imaging animals that nuclear physicians use on humans, but they usually need to modify the dosages and the computer studies to analyze the results. "A typical horse gets about 150 millicuries of ^{99m}Tc -methylene diphosphonate (MDP) for a bone scan compared to a human dose of 30 millicuries," said Chambers.

The advantage of bone scintigraphy is that it is extremely sensitive and can detect the smallest changes in bone remodeling (which signifies healing) within 24 hours after an injury. Diagnosing stress fractures in their earliest stage can ensure that a horse doesn't overwork its injury and can prevent a minor injury from developing into a full fracture, which can result in permanent disability. Radiographs, on the other hand, are more specific in terms of diagnosis, but they may not be able to detect the slight density changes caused by a small fracture for upwards of 10 days. Seeing a negative result on a radiograph could falsely reassure owners that their horses don't have a fracture and can go back to racing. "In most cases, we use scintigraphy as a screening tool to see if there's any change in bone turnover or remodeling," Chambers said. "We then take a radiograph to pinpoint the type and size of the fracture. Both imaging modalities are very

kinds of work—racing as opposed to jumping, for instance. "With race horses, we've seen increased scintigraphic uptake around the joints where stress is placed during training and racing," said Chambers. "But we don't know whether the bone or the cartilage fails first." Results from these studies could be applied to human research. For instance, Olympic pole vaulters probably stress their bones in different areas than long distance runners. Once these weak spots are identified, athletes could tailor their weight training to strengthen the bones that are most stressed and help avoid fractures.

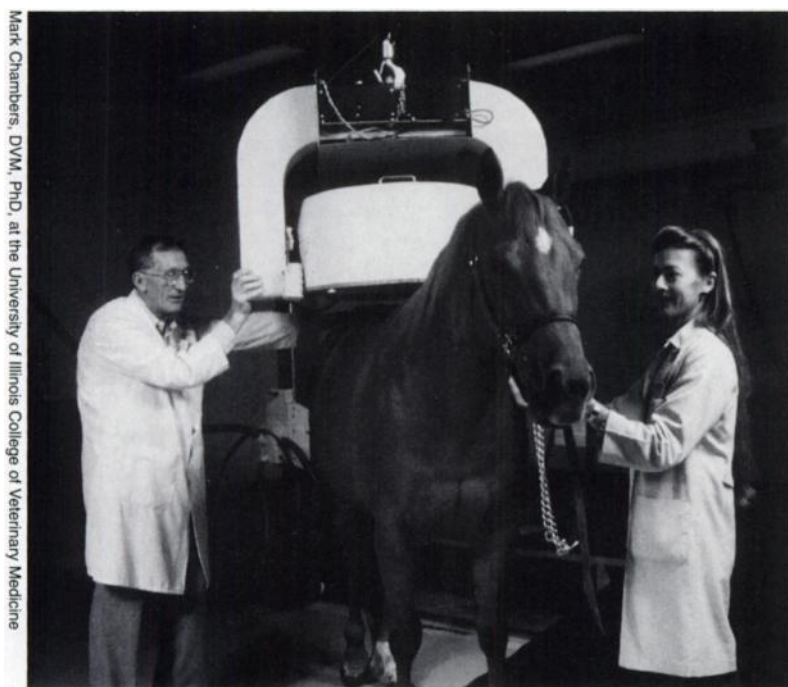
House Pets or Lab Animals?

When veterinarians perform nuclear medicine research on animals, often the "guinea pigs" are their patients. For instance, to see how well scintigraphy predicts bone metastases, researchers have studied dogs with osteosarcomas that have occurred spontaneously. The study, performed at the College of Veterinary Medicine at NCSU, found that those tumors with high uptake counts before chemotherapy treatments were more likely to metastasize earlier than those with lower counts. (*J Nucl Med* 1992;33:1542.) The researchers also found that the greater the ratio between the pre- and post-treatment uptakes, the greater the likelihood that the tumor was more aggressive. Since osteosarcomas behave very similarly in both dogs and humans, this particular finding could serve as an animal model for human trials.

In more recent research, the NCSU researchers performed PET scans on four dogs with osteosarcoma using ^{18}F -labeled Fab fragment of TP-3, a monoclonal antibody specific for osteosarcoma in human and dogs. (*J Nucl Med* 1994;34:1506.) "They found this to be an effective imaging agent for targeting this specific cancer cell line in dogs," said Berry.

Berry emphasizes these studies aren't typical animal experiments since the dogs come in as sick patients who need to be diagnosed and treated. "We aim to get a diagnosis and start treatment as early as possible," he said. "Predicting the outcome of the treatment based on the uptake of radiotracers in the cells is interesting for research purposes, but it doesn't help the patient at this point." However, the findings could have broad implications in terms of human research and clinical application. One possible use could be for cancer prognosis if nuclear scans are shown to be effective for staging and evaluating tumors, he said. This could set nuclear medicine apart from other imaging modalities, such as CT, MRI and ultrasound, which are also used for cancer diagnosis.

Another major impact that veterinary research



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compatible to give us information on the physiology and morphology of the bone."

Besides working with horses in the clinical setting, Chambers is also performing research on bone scintigraphy to see if there are specific stress patterns in the bones of horses who do different

is having on nuclear medicine is in the area of testing the effects of chemotherapy drugs on organs such as the kidneys. Gregory B. Daniel, DVM, an associate professor of radiology at the University of Tennessee College of Veterinary Medicine, has performed nuclear scans on 15 dogs being treated for cancer with the chemotherapeutic agent, cisplatin. He measured the drug's effects on the dogs' kidneys by obtaining glomerular filtration rate (GFR) scans and comparing the measurements to a control group. He found that the dogs on cisplatin had on average a 12 percent decrease in kidney function or GFR rate, while the control group showed a slight increase in functioning.

In order to measure organ function in animals, researchers must modify the technique used in humans to calculate new quantitative measurements. Although GFR rates for kidneys have been well established, veterinarians still don't have clearance rate measurements for other organs such as the liver. In order to adapt liver scanning for use in dogs, Daniel is currently conducting computer studies to measure the extraction rate of a radiopharmaceutical from canine livers. This requires two steps: First, he must establish what the normal rate of extract is in healthy dogs, then in dogs with liver disease. "A dog food company that has a product designed to treat liver disease is particularly interested in my research," Daniel said. "They need some way to assess if their food has a beneficial effect on the liver function of dogs."

Animals Aren't Humans

Given that veterinary nuclear medicine is still fairly new, it's understandable that the veterinarians have to iron out a few wrinkles in their day to day practices. Some problems may be smoothed over once the field becomes more widespread in private clinics and hospitals. Others may remain since they are inherent in the nature of veterinary medicine. For example, veterinary procedures aren't covered by any medical insurance, so pet owners must pay for all tests and treatments themselves.

"We don't get carte blanche to do any test we want," said Berry. He feels that he and his colleagues must be more selective in what scans they order than nuclear physicians whose tests are covered by insurance. "We're always walking a fine line between giving the most thorough diagnosis and treatment and knowing when to call it quits," he said. "We have to remember that we're treating pets not human, even though they may be beloved members of the family." (Of course, some attached pet owners believe the lines are blurred.)

Veterinarians also face a problem that nuclear physicians can relate to—the Nuclear Regulatory

Commission (NRC). Under NRC regulations, all animals fall into the same category of research animals. If they have a nuclear medicine procedure, they must be quarantined until they reach near-background levels of radiation. This means that a cat treated with ^{131}I for hyperthyroidism must stay in the hospital for two to three weeks until its emissions decrease. The cost of room and board can bring a relatively inexpensive procedure up to a total of \$500 to \$800. "The Society of Veterinary Nuclear Medicine is trying to establish a guideline specific to these release criteria so that standards for pet release aren't as stringent," said Berry.

In the day to day world of imaging, veterinarians are finding that qualified technologists, who want to dedicate themselves to animal imaging, are hard to come by. Ideally, Berry said, his institution would like to hire only technologists who are certified in nuclear medicine. However, they usually have a hard time filling the positions because of salary constraints. According to Berry, the average starting salary for a veterinary technologist is \$18,000 to \$28,000 compared to the typical starting salary of \$30,000 to \$32,000 for a nuclear medicine technologist at a human hospital. Often veterinary hospitals hire general veterinary technologists or radiology technologists who have some additional training in nuclear medicine.

Another valuable resource that's a rarity: research subjects for studies. Since fewer animals pass through oncology units than humans, researchers often have difficulty filling their studies. Usually they're happy to have just a handful of subjects for a given study. For instance, Daniel said at his institution they would like to study imaging for thyroid carcinoma in cats. Yet, only 5 percent of the cats treated for thyroid problems actually have tumors. "In all, we treat about 60 cats a year for hyperthyroidism, which means only 2 or 3 pass through with thyroid cancer," he said.

Perhaps solutions for these problems may come slowly since the field is still a small subspecialty. (The Society of Veterinary Nuclear Medicine only has 55 members. For more information on the Society, contact Chambers at (217) 333-2000.) In fact, there is no formal residency program in veterinary nuclear medicine. Residents usually specialize in veterinary radiology and then do a fellowship in nuclear medicine. Although veterinarians don't expect nuclear medicine to grow to the heights that it has in the medical field, they're hoping that procedures such as thyroid treatments and bone scans become as commonplace in private vet clinics as they are now in nuclear physicians' offices.

—Deborah Kotz