A Look Inside the Nuclear Medicine Service
Part of the internationally recognized Veterinary Diagnostic Imaging Section

Diagnostic and Medical Imaging
The Nuclear Medicine service is part of the Veterinary Diagnostic Imaging (VDI) Section at the Veterinary Teaching Hospital (VTH). The internationally recognized VDI Section is comprised of six faculty radiologists, one fellow, one post-doc, five residents, ten technologists, three office staff, and a PACS administrator, database specialist and numerous student workers. This Section of the VTH has an annual imaging caseload of nearly 16,000 patients, providing CT, MRI, digital and computed radiography, fluoroscopy, ultrasound, and nuclear medicine services. Instruments utilized by the VDI Section include a variety of ultrasound machines, a PET/CT scanner, dual head gamma camera and equine gamma camera, a 1.5 Tesla MRI machine for companion animals and an MRI for equine use. In addition to the standard radiography exam rooms, a new C-arm fluoroscope and interventional radiology suite has recently been installed. The types of animals examined by the VDI Section range from companion animals such as dogs, cats, birds and ferrets to larger animals such as horses, cattle, sheep, goats and exotic animals of all sorts.

Nuclear Medicine is a medical specialty involving the application of radioactive substances in the diagnosis and treatment of disease. Nuclear medicine scans are conducted by certified radiologic technologists at the VTH. Nuclear Medicine, in a sense, images the patient from the inside out because it records radiation from within the body rather than radiation that is generated by external sources like x-rays. In nuclear medicine imaging, radiopharmaceuticals are administered to the patient subcutaneously, intravenously or orally. Then external detectors or gamma cameras, capture and form images from the radiation emitted by the radiopharmaceuticals within the patient’s body. This process is quite different from a radiograph, where external x-rays are passed through the body to form an image.

2D or planar imaging: Scintigraphy is the use of internal radionuclides to create 2D images

Renal Scintigraphy is a form of kidney imaging involving radioisotopes and is utilized when a patient has an abnormal lab test, or a possible cancerous tumor. The radioisotope Technetium-99m Diethylene Triamine Pentacetic Acid (DTPA) is filtered by the glomerulus (a cluster of capillaries at the beginning of the nephron) and is used to determine the function of each kidney and the possible consequences of surgical procedures. Renal Scintigraphy is also used for research purposes and in particular, for the study of stem cell treatment of chronic kidney disease in cats. The VDI Section has done work in the past with Dr. Jessica Quimby to document the effects of stem cell treatment on Stage IV kidney disease. For more info on the Mesenchymal Stem Cell Treatment please see: http://csu-cvmbs.colostate.edu/vth/veterinarians/clinical-trials/Pages/stem-cell-treatment-of-stage-iv-chronic-kidney-disease-in-cats.aspx.

A bone scan or bone scintigraphy is a nuclear medicine procedure used to help diagnose a number of conditions of the musculoskeletal system including: bone tumors or cancers that have metastasized to the bone, sites of inflammation or infection and the diagnosis of stress fractures that may not be visible in traditional radiographic images. The Equine Nuclear Medicine service uses bone scans to find the source of difficult lameness issues. Soft tissue trauma can also be identified during the soft tissue phase of the scan. For a bone scan, the patient is injected with Tc99m-HDP (oxidronate disodium) and then scanned with a gamma camera. The average dose of Tc-99m for a large dog is 8 mCi (296 MBq) and a horse is ~180 mCi (6.66 GBq).
Nuclear Medicine Service continued

A portosystemic shunt (PSS) is a bypass of the liver by the body’s circulatory system. The VDI Nuclear Medicine service has been performing portosystemic imaging since the early 1980s. A trans-colonic or trans-splenic injection of Tc99m is used to produce a 3 minute dynamic study which can verify the presence and the approximate severity of a PSS within the patient. A shunt can be either a congenital (present at birth) or an acquired condition. Congenital shunts are a hereditary condition in dogs and cats and its frequency varies according to breed. Small dog breeds usually have extrahepatic (outside the liver) shunts, while large breed dogs tend to be intrahepatic (inside the liver). Acquired PSS is also found in dogs and cats with liver diseases resulting in cirrhosis and portal hypertension.

Lymphoscintigraphy is scintigraphic documentation of the position and number of sentinel lymph nodes associated with a tumor. The primary isotope used is Tc-99m labeled with sulfur colloid; however the use of a receptor-targeted nanoparticle product is greatly increasing. Identification of the affected lymph nodes can be performed using a gamma camera or by using a hand-held gamma probe in surgery.

Radioiodine therapy
Iodine-131 (I-131) is a beta-emitting isotope with a half-life of eight days, and is comparatively energetic (190 keV average and 606 keV maximum energy) beta radiation, which penetrates 0.6 to 2.0 mm from the site of uptake. This beta radiation can be used for the destruction of hyper-functioning thyroid tissue. In veterinary medicine, I-131 is used for the treatment of thyroid carcinomas or adenomas which cause hyperthyroidism in dogs and cats. Hyperthyroidism is a common disease of older cats. Feline patients receive a technetium scan to help confirm the diagnosis and determine the extent of the disease. For those with hyperthyroidism, a curative dose of 2-4 mCi (74-148 MBq) of I-131 is administered to the patient subcutaneously. The I-131 will deliver a therapeutic dose of radiation to the hypermetabolic thyroid tissue; normal tissues are spared because the beta particle of the I-131 delivers the radiation dose primarily to the hyperfunctioning cells. This treatment is safe for the cats and has a high rate of success. After treatment the patients remain at the VTH for 3-4 days to monitor their recovery and ensure the levels of radiation in their body have decreased sufficiently for release. Thyroid carcinoma patients receive much higher doses of I-131 and are hospitalized for a minimum of 8 days to meet radiation safety requirements.

3D or cross-sectional imaging: Positron Emission Tomography and Computed Tomography (PET/CT), is a nuclear medicine, functional imaging technique that produces a three-dimensional image of functional processes in the body.

The system detects pairs of high energy photons emitted indirectly by a positron-emitting radionuclide (tracer), which is introduced into the body on a biologically active molecule. Three-dimensional and dynamic images of tracer concentration within the body are then constructed by computer analysis. F-18-FDG (a glucose analog), has long been the gold standard for noninvasive imaging of cancer in humans and animals. PET/CT is utilized to locate the margins of an infiltrative cancer in animals. PET information helps to determine the exact tumor margins so that radiation therapy and surgery can be done more effectively. PET is also used for the detection of metastasis to other areas of the body and to document responses to therapy. The VDI Section is exploring F-18-FDG use in musculosketetal imaging of sports medicine and orthopedic patients at the VTH. Fluorine-18 is the most common radioisotope in these imaging protocols, but Cu-64 and Zirconium-89 are positron emitters with longer half-lives that have exciting medical imaging research potential.

Vet Students Participate in Patient Diagnosis & Treatment
Professional veterinary medical students interact with radiologists, residents and technologists in the VDI Section to obtain and interpret diagnostic imaging studies. Clinical rotations in the 3rd and 4th years of their training allow veterinary students to gain confidence by performing imaging procedures and formulating diagnostic and therapeutic plans for their patients.
New PET Imaging Technique May Detect Cancer More Easily

Researchers say a new PET imaging system provides doctors with a “whole body map” to detect cancerous tumors.

A breakthrough in imaging techniques could significantly improve early detection and care for people with cancer, especially those with multiple tumors.

The research was announced in June at the 2015 annual meeting of the Society of Nuclear Medicine and Molecular Imaging (SNMMI) in Baltimore, Maryland.

Scientists have developed a technique for clinical PET imaging that uses innovative bed positioning and advanced data analysis. The method also uses a chemical tracer that aids in the detection of tumor lesions.

The new approach allows the creation of whole body “maps” from which radiologists can make evaluations of tumors and metastases as well as secondary malignant growths that occur away from the primary cancer site.

“For patients with multiple tumors, this technology could significantly improve the contrast and quantitation of their PET scans and, therefore, the quality of their care,” said Ning Guo, Ph.D., a research fellow in the department of radiology at Massachusetts General Hospital and Harvard Medical School in Boston.

Guo added the imaging could have an impact on disease management by contributing to earlier diagnosis and more accurate prognosis.

“It not only discriminates among benign tumors, inflammation, and malignancy,” he said, “but also provides insight about malignant lesions that are atypical or unclear, a common challenge when using PET.”

Utilizing More Than One View

Existing clinical PET scanners have only one position, which allows for only a limited field of view — a small picture of less than 1 foot of the patient’s body, Guo said. This limitation makes it impossible to evaluate multiple cancerous lesions in other body areas. With the new, whole-body technique, the imaging “bed” moves between different views to capture a complete picture of lesions throughout the patient’s body within a specific time frame.

The research was conducted by Harvard Medical School and Massachusetts General Hospital in Boston in conjunction with scientists who carried out imaging on patients at Peking Union Medical College Hospital in Beijing, China.

In the study, 16 lung cancer patients went through an hour-long PET scan that included the measuring of data from four different bed positions. The resulting precise, whole-body maps clearly captured primary tumors in the lung as well as scattered lesions, researchers said.

According to the SNMMI, this new method of PET imaging — after continued study and pending regulatory approval — could be used in clinical imaging for lung cancer. It also has the potential to be used to detect a range of other cancers.

The American Cancer Society estimates that in 2015 about 221,200 new cases of lung cancer will be diagnosed in the United States and 158,040 patients will die from the disease.

Radiation Do’s and Don’ts

No shorts or sandals in the lab

The warmer summer months are upon us and many people prefer to wear shorts or short skirts and sandals to be comfortable. Lab Safety requires legs to be covered and closed toe shoes to be worn. The RCO recommends keeping a pair of comfortable pants and shoes or a pair of scrubs in your office to change into when you are going to be working in the lab.