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Osteosarcoma (bone cancer)

Definition
Osteosarcoma (OSA) accounts for only approximately 5% of all canine tumors, but is by far the most common bone tumor of the dog. It is a malignant tumor of the bone and can develop in any bone, but most often occurs in bones bordering the shoulder, wrist and knee. Osteosarcoma of the limbs is called appendicular osteosarcoma and accounts for 75-85% of the cases of bone cancer. However, these tumors can also affect the axial skeleton (cranium, spinal column, ribs).

Osteosarcoma develops deep within the bone and becomes progressively more painful as it grows outward and the bone is destroyed from the inside out. Lameness may occur suddenly or start intermittently and progress over several weeks. Obvious swelling becomes evident as the tumor grows and normal bone is replaced by tumorous bone.

Tumorous bone is not as strong as a healthy bone and can break with minor injury. This type of broken bone is called a pathologic fracture. Pathologic fractures will not heal, therefore it is critical to diagnose and start treatment for osteosarcoma before this occurs.

Osteosarcoma usually occurs in middle aged or elderly large and giant breed dogs but can occur in a dog of any age with larger breeds tending to develop tumors at younger ages.

Highly aggressive and metastatic in nature, over 90% of all clinically significant osteosarcomas have already micrometastasized by the time of diagnosis. Most metastasis happens via menatogenous spread to the lungs and other bones, but lymph node metastases have been reported.



Slings like this are extremely helpful post-amputation.

Click on the picture to purchase.



Diesel beat osteosarcoma.
[Read his success story!](#)

Are you curious to see how well dogs adapt to life on three legs? Watch the videos below of tripod dogs in action!

Causes

The specific cause of osteosarcoma is not known. However, because osteosarcoma tumors are frequently found near growth plates, it is speculated that factors that affect growth rates, such as diets that promote rapid growth in puppies, appear to influence risk.

Osteosarcomas tend to anchor themselves in areas of increased bone remodeling, said Dr. Kim Cronin, oncologist at the University of Pennsylvania. "Every time you have cell damage or increased turnover, the DNA is more likely to make a mistake when coding for new cells, which can lead to tumor formation." So naturally, previous fractures and chronic bone infections are predisposing factors. These tumors are most likely to occur in the limbs, particularly the forelimbs, which bear most of the body weight; other bones, such as the ribs and skull can also be affected."

Ionizing radiation, chemical carcinogens, and foreign bodies (including metal implants, such as internal fixators, bullets, and bone transplants contribute to the development of osteosarcoma. In addition, there have been correlations with genetic predisposition to tumor development in certain family lines. Dogs with osteosarcoma have been found to have aberrations of the p53 tumor suppressor gene. In laboratory animals, both DNA viruses (polyomavirus and SV-40 virus) and RNA viruses (type C retroviruses) have been found to induce osteosarcoma.

Research was performed in 2002 to determine if spaying or neutering a dog increased the risk of developing bone cancer. Experimental and clinical evidence suggests that endogenous sex hormones influence bone sarcoma genesis but the hypothesis had not been adequately tested in an appropriate animal model. A historical study was conducted of Rottweiler dogs because they frequently undergo elective gonadectomy and spontaneously develop appendicular bone sarcomas, which mimic the biological behavior of the osteosarcomas that affect children and adolescents.

In summary, this study found that male and female Rottweilers with the shortest lifetime gonadal exposure had the highest risk for bone sarcoma. Dogs that underwent early elective gonadectomy had a one in four lifetime risk of bone sarcoma development compared with a significantly reduced risk among dogs that were sexually intact throughout their lifetime. Although it remains unclear how endogenous gonadal hormones influence bone sarcoma development, the work provides the framework for selecting a target population for bone sarcoma prevention studies. To read the complete study, please click here:

<http://cebp.aacrjournals.org/cgi/content/full/11/11/1434>

A two-year study conducted by the National Toxicology Program (NTP), using rats and mice, linked sodium fluoride in drinking water to osteosarcoma. The positive results of that study (in which malignancies in tissues other than bone were also observed), concurs with a host of data from tests showing fluoride's ability to cause mutations and data showing increases in osteosarcoma in young men in New Jersey, Washington and Iowa based on their drinking fluoridated water.

A sister chemical to lufenuron, which is a popular insect growth regulator used orally for flea control in dogs and cats, is diflubenzuron. Two metabolites of diflubenzuron, para-chloroaniline (PCA) and 4-chlorophenylurea (CPU), increased the incidence of hemangiosarcoma and osteosarcoma in animal studies. Lufenuron accumulates in fatty tissue.

A few studies with human osteosarcoma patients discovered low blood serum levels of zinc and selenium, but the relationship of these nutrients to the cancer are not yet understood. Evidence suggests that a predisposition to osteosarcoma runs in families. Studies with humans point to a connection with hereditary cancers. For example, the gene involved in familial retinoblastoma appears to be a defective tumor inhibitor gene and is associated with other childhood tumors including osteosarcoma. We know that in humans and canines, tumor-suppressor genes like P53 produce proteins that inhibit tumor formation. If these genes are not present, or are damaged, the individual is more susceptible to tumor formation.

The risk of bone cancer is slightly higher in males than females. In addition, it is 65% higher for castrated males and 34% higher for spayed females. The probability of developing bone cancer was higher both in females spayed at less than one year of age, as well as males castrated when they were less than a year old, compared with animals that were not spayed or neutered.

Apparently, sex hormones are somewhat protective against the disease.

Do you want to know here to get a vest like Jerry in the video above? Jerry endorses the Animal Suspension Technology Pet Support Suit™

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Symptoms

Because osteosarcoma usually presents in one of the limbs, the most common symptom of the typical canine osteosarcoma is lameness with or without a noticeable and sometimes painful swelling or mass at the tumor site. The lameness is either due to periosteal inflammation, microfractures, or pathologic fractures. If swelling exists, it is likely due to extension of the tumor into the surrounding soft tissues.

The typical symptom for dogs with mandibular (lower jaw bone) and orbital site tumors is dysphasia (difficulty swallowing). Dogs with cranial (skull) or vertebral tumors will present with neurologic deficits. Dogs with pelvic masses may have dyschezia (difficulty defecating) as their primary symptom.

Diagnosis

Diagnosis of canine osteosarcoma is initiated with complete orthopedic and neurologic examination (to rule out other causes of lameness), physical examination, and regional radiographs (x-rays). Some oncologists have suggested that biopsy is not needed if the radiographs show an obvious bone tumor, however, if there is any question about the lesion on the radiographs, a bone biopsy should provide clear results.

To obtain a definitive diagnosis, it is necessary to aspirate the tumor with an ultrasound-guided needle or perform a bone biopsy (removal of a tiny section of the bone) in order to attempt to identify the type of tumor. These procedures require sedation or anesthesia as they would otherwise be painful. There is often a large amount of bony reaction associated with this type of tumor, so it can be difficult to obtain an adequate sample of the actual tumor cells. Additionally, small samples are taken in order to minimize the spread of the tumor cells along the biopsy pathway and to avoid fracturing the bone. For these reasons, the biopsy procedure does not always yield a diagnostic sample. Even though only very small samples are taken, and bone biopsies are performed with the utmost care, this procedure always carries a small risk of fracturing the bone.

If osteosarcoma is diagnosed, radiographs (x-rays) of the dog's chest are taken to see if the tumor has spread to the lungs. It is important to find out whether the cancer has spread (metastasized) to the lungs, as treatment options and prognosis are very different if lung metastasis has occurred. Up to 90% of these tumors will have metastasis to the lungs at the time of diagnosis, but because of the small initial size of the metastases, less than 10% will initially show up on a chest x-ray. Because of this high incidence of metastasis, all dogs with osteosarcomas are treated as if they have metastasis to the lungs regardless of the findings on the initial lung x-rays. In the initial diagnostic stages, aspirate (sampling of cells) of lymph nodes and any skin masses and an abdominal ultrasound are generally done. Again, these steps are necessary in order to assess the spread of the cancer and health of the dog.

Another diagnostic test that may be performed is a bone scan. This test, which requires an overnight stay in the hospital, will help determine whether the tumor has spread to other bones and how much of the bone where the primary tumor is located is affected.

The location and radiographic appearance of the osteosarcoma in the limb are quite classic but there are a few other possible conditions that cause lytic lesions in bone: the chondrosarcoma,

Stories of dogs with osteosarcoma

Beanny (Rottweiler)	http://www.caninecancer.com/beanny.html
Jerry the Tripawd	http://www.tripawds.com/
Allie's Story (Golden)	http://www.handicappedpets.com/gallery/allie/
Breeze the Irish Wolfhound	http://breezebabys.blogspot.com/
Hal the Great Dane	http://rhallenbeck.tripod.com/
Shannon's Story	http://members.aol.com/reinbeaux/shannon/shannon.htm
Chuck the Miracle Dog	http://miraclepooch.wordpress.com/



A picture of Athena (left), before her cancer diagnosis and the tumor that appeared on her left scapula. Athena was diagnosed with bone cancer and is not a candidate for amputation because she is lame in her hind quarters and the cancer has spread to her lungs. What a beautiful girl - January 2008. Sadly she passed away in the summer of 2008.

Sampling of Current Clinical Trials for Dogs with Osteosarcoma

[Study Name:](#)

[Oral Artemisinin in Dogs with Spontaneous Tumors](#)

Purpose of study: We are studying the drug artemisinin, a drug used originally for the treatment of malaria in South Asia, but which was also found to kill cancer cells due to free radical generation through a reaction mediated by iron. Artemisinin has been shown to have effects in several types of human cancer cells in vitro. We have previously shown that low concentrations of artemisinin can induce cell

or the squamous cell carcinoma, or the synovial cell sarcoma. For these reasons, many veterinary oncologists will recommend a bone biopsy to confirm the diagnosis.

Chondrosarcoma is a cartilage tumor, possibly not as malignant as the osteosarcoma. The chondrosarcoma generally occurs on flat bones such ribs or skull bones and is not usually found in the limbs. Still, should a chondrosarcoma occur in the limb, treatment recommendations would still include amputation of the affected bone and biopsy of the tissue after amputation would allow for any adjustments in chemotherapy.

Squamous cell carcinoma is a tumor of the external coating of the bone (called the "periosteum"). This is a very destructive tumor locally but it tends to spread relatively slowly. Again, a bone suspected of malignant tumor should be amputated and the tissue then analyzed and treatment adjustments made thereafter. The squamous cell carcinoma tends not to arise in the same bone areas as the osteosarcoma; it tends to arise in the jaw bones or in the toe bones.

Synovial cell sarcoma is a tumor of the joint capsule lining. It's hallmark is that it affects both bones of the joint. The osteosarcoma, no matter how large or destructive it becomes, will never cross over to an adjacent bone.

Fungal bone infection: *Coccidioides immitis* is a fungus native to the Lower Sonoran Life Zone of the South West U.S. It is the infectious agent of the disease called "San Joaquin Valley Fever" or just plain "Valley Fever." (More scientifically, the condition is called "coccidioidomycosis.") In most cases, infection is limited to a few calcified lymph nodes in the chest and possibly lung disease. In some rare cases, though, the fungus disseminated through the body and can cause a very proliferative bone infection. The bone infection of coccidioidomycosis is proliferative and lacks the lytic lesions that are so typical of the osteosarcoma.

Treatment

Osteosarcoma is an aggressive, highly metastatic cancer that requires an aggressive treatment plan. Treatment of canine OSA has one of two goals: palliation of pain and lameness or curative intent. There is some interesting and potentially promising new research being done with the drug Artemisinin and dogs with bone cancer. Please see our [Herbal page](#) for more details.

used at different facilities radiation therapy is usually applied to the tumor in 3 doses (the first two doses 1 week apart, the second two doses 2 weeks used at different facilities radiation therapy is usually applied to the tumor in 3 doses (the first two doses 1 week apart, the second two doses 2 weeks apart.) Improved limb function is usually evident within the first 3 weeks and typically lasts 4 months. When pain returns, radiation can be re-administered for further pain relief if deemed appropriate based on the stage of the cancer at that time.

administered for further pain relief if deemed appropriate based on the stage of the cancer at that time.

The disadvantage of radiotherapy is that when pain is relieved in the tumorous limb, dogs will increase activity, which can in turn lead to a pathologic fracture of the bone. Also, radiotherapy does not produce a helpful response in about some dogs.

Analgesic medications such as carprofen, etodolac, aspirin, butorphanol, and fentanyl patches are all available but, unfortunately, they are no match for the pain involved in what amounts to a

death in several types of canine cancer cells in vitro. Artemisinin has been used in clinical cancer treatment for people, and in dogs with osteosarcoma, with daily administration of small doses. However, there are few reports of successful outcomes. We hypothesize that a weekly, high-dose of artemisinin will be well tolerated and will result in clinically relevant plasma concentrations to effect tumor growth, whereas a low daily dose will not.

[Various clinical trials at Colorado State:
GENE THERAPY FOR CANINE OSTEOSARCOMA](#)

[CANINE OSTEOSARCOMA: EVALUATION OF AN
INVESTIGATIONAL
DRUG AS TREATMENT OF PULMONARY METASTASIS](#)

[ROLE OF REGULATORY T CELLS IN DOGS WITH OSTEOSARCOMA](#)

[OSTEOSARCOMA SENTINEL LYMPH-NODE STUDY](#)

[TARGETED IMMUNOTHERAPY COMBINED WITH RADIATION
THERAPY FOR TREATMENT OF PULMONARY METASTASES](#)

July 2008 - Bo's Story of Hope



I just want to give you an update on Bo, my black Labradane who was diagnosed with osteosarcoma and had a rear leg amputation March 2007. He's a strong boy and we've had a lot of prayer and support in our journey. We completed 5 rounds of chemo in August 2007, enjoyed 7 months of remission, and removed 1 lung lobe for a single metastatic lump in April 2008. He's made an excellent recovery, and continues on metronomic chemo which he tolerates well. Possibly the lung surgery was his cure-only future chest xrays will tell. Bo is 11-1/2 years old, and lucky enough to have a little regular "old dog arthritis".

Attached is a photo of Bo and me, May 2008, 10 days after surgery, posed with his "fur & leg side out". We make sure every day is his best day yet!

Thank you for your encouragement, and for being there for pets and their best human friends.

More from Sandy about Bo's Treatment:

I realize our journey is the exception to osteosarcoma, and I feel it would also be important to mention that prior to amputation, Bo was evaluated by his local vet and orthopedic surgeon as a strong candidate for treatment-meaning his hips, heart, weight, and blood

slowly exploding bone. These medications may be palliative at some stage but generally do not provide meaningful pain relief long term.

Curative intent options include combining different modes of therapy such as surgery, radiation therapy, and chemotherapy. The bottom line is that the tumor must be removed from your dog's leg. Aside from the possibility that the cancer will spread, the tumor is painful, and once it has destroyed enough of the bone, even normal activities such as walking or running can cause the bone to break. The standard treatment for an osteosarcoma is the amputation of the affected limb. Most dogs recover quite well from this procedure and are running and playing in a very short time.

Removal (amputation) of the affected limb resolves the pain in 100% of cases. Unfortunately, many people are reluctant to have this procedure performed due to misconceptions. While losing a leg is very handicapping to a human, losing one leg out of four does not significantly restrict a dog's activity level. Running and playing are not inhibited by amputation after the surgical recovery period is over. The loss of a limb is disfiguring to humans and has social ramifications, dogs really are not so self-conscious about their image. The dog will not feel disfigured by the surgery; it is his or her owner that will need to adjust to the new appearance of the dog. However, it is important to remember that amputation is major surgery and is not without risk of complications. One of my dogs developed a pulmonary embolism the day after his amputation surgery and died. While this is not common, you should be aware of it. In addition, if your dog is overweight, it is highly advisable to put your dog on a diet prior to surgery to make it easy for them to adjust to life on three legs.

Dogs who have other orthopedic problems or who are obese, may not be good candidates for amputation. Some owners may also not want to have their dog's leg amputated. If this is the case, a limb sparing (also know as limb salvage) procedure may be possible. In this procedure, the tumor is removed and the bone is replaced either with another bone from your dog or with a bone from a bone bank. This operation cannot be performed in all locations and the tumor must be of a relatively small size at the time of diagnosis.

The most common site where limb spare procedures can be done is for the distal radius, which is the bone just above the wrist of the dog. There is a high complication rate with this procedure and it often involves a more involved recovery than an amputation. Because of the high complication rate, amputation may eventually be necessary.

Limb-sparing techniques were initially developed for humans and have been adapted for dogs. To spare the limb (and thus avoid amputation), the tumorous bone is removed and either replaced by a bone graft from a bone bank or the remaining bone can be re-grown via a new technique called "bone transport osteogenesis." The joint nearest the tumor is fused (i.e. fixed in one position with a plate and cannot be flexed or extended.). It is important to understand that limb sparing cannot be done if more than 50% of the bone is involved by tumor or if neighboring muscle is involved and that limb sparing does not work well for hind legs or tumors of the humerus ("arm" bone.). It works best for tumors of the distal radius ("forearm" bone).

Complications of limb sparing can include: bone infection, implant failure, tumor recurrence, and fracture and loss of up to 50% of the treated limb, resulting in limited activity for the dog. Limb sparing is performed in conjunction with chemotherapy (and in some instances, radiation therapy). It may be the best option. New techniques are being explored to decrease the rate of bone formation. Radiation therapy can be effective in destroying neoplastic cells at the primary tumor site, and chemotherapy may be employed to prevent or delay

tests were excellent and we entered treatment with no compromises.

Bo has been treated by a board certified veterinary oncologist who follows the Colorado State protocols and one of the finest thoracic surgeons in the USA. Treatment requires a serious commitment of time, emotion, and money with no guarantee of outcome.

What the vets didn't tell me: one must be able to lift their dog. Bo can no longer jump into the car, climb stairs, walk up ramps or sloping ground. Ice and laminate floors are dangerous to an amputee. We sometimes resort to the sling. As for walking, he no longer backs up or turns in a tight radius. A normal correction with the leash can put him off-balance and cause a fall, so he must be handled verbally and with patience. An injury to his hind leg could end our treatment plan. For this reason, Bo has not been kennelled, and I've not travelled, since March 2007.

Bo (80 lbs) has followed a simplified "Beany's diet": 1 soup can (10 oz size) Iams Healthy Natural dry food + 8oz. protein (cottage cheese, plain yogurt w/active culture, white chicken or turkey, salmon or fish, boiled ground lean beef, or Gerber's baby food meat) + 4 oz. brown rice + 4 oz. mixed veggies DAILY. During chemo and pain meds, we split this amount into 2 - 4 meals per day along with a pill for anti-vomit and a pill for anti-diarrhea. Bo normally eats once daily. After amputation, he gained 8 lbs, which put too much pressure on his hind leg, so all treats were subtracted from the above diet until he lost the extra pounds.

After completing his chemo (carboplatin and adriamycin) Bo had diarrhea for MONTHS. We used more active culture yogurt and no beef to help re-establish good bacteria in his digestive tract.

Since March 2007 he has taken a canine dietary supplement called CAS Options to boost his immune system and Dasuquin, a canine joint supplement. Additionally, he takes Piroxicam (replacement for Deramaxx) and his metronomic chemo now. He had a few weeks of prednisone earlier this year to alleviate some arthritic inflammation. I still keep the anti-vomit & diarrhea meds on hand for use as needed.

For Bo and me, treatment is the right decision. Initially, I viewed it as buying us time together, not knowing how much we'd get. We've both made enormous sacrifices to be together. We're now in the land of clinical trials, since not many osteosarcoma dogs make it this far. Bo goes to work with me every day, and has a following of human & canine friends who visit. We hope to continue getting old together for a long time!

radiation therapy as well). At this time, the only good results are in dogs with tumors of the distal radius (the "wrist" joint). More than three-quarters of these patients return to metastasis. Carboplatin, cisplatin and doxorubicin, are part of a typical, after surgery osteosarcoma chemotherapy protocol. near normal function. Radiation therapy can be effective in destroying neoplastic cells at the primary tumor site, and chemotherapy may be employed to prevent or delay metastasis. Carboplatin, cisplatin and doxorubicin, are part of a typical, after surgery osteosarcoma chemotherapy protocol.

Since metastasis is the most common cause of death in dogs with osteosarcoma, the addition of chemotherapy into curative intent protocols is vital to longer term survival. They are used either in combination with surgery or radiation therapy in an attempt to decrease the metastatic rate. Cisplatin, Carboplatin and Doxorubicin (Adriamycin) are examples of agents currently used in standard practice to help control metastatic disease. Their use markedly increases survival times beyond those of amputation or tumor removal alone.

Though there may not be visible evidence of the spread of tumor in the patient, it is estimated that over 90% of dogs with this type of tumor have microscopic spread before amputation or limb sparing procedures are performed. Although chemotherapy has not been shown to be very effective in treating osteosarcoma when there are visible signs of spread, it is very effective in treating microscopic disease. Again different protocols are used at different facilities but most use some combination of cisplatin or carboplatin along with doxorubicin. In most published studies chemotherapy as a follow-up treatment increases the median life expectancy to about one year. The median survival time with amputation alone is about three months. By two years 10-20% of the dogs who have received chemotherapy appear to be free of cancer. Most dogs tolerate the therapy very well and experience few side effects. Although side effects can include vomiting and diarrhea or infection due to decreased white blood cells in a small percentage of patients. If any of these signs do occur it is important that the owners seek veterinary care right away.

The most successful drugs have been carboplatin and cisplatin. Carboplatin is more expensive, but safer and easier to administer. Doxorubicin is sometimes used as well. A qualified veterinary oncologist is often the best source of information and he or she will be aware of the newest chemotherapy protocols. The life expectancy of a dog with a properly identified and treated osteosarcoma varies greatly, but can approach a year or longer. Implantable cisplatin chemotherapy has been used to treat dogs with osteosarcoma with encouraging results.

DRUGS:

- Chemotherapy is the only meaningful way to alter the course of this cancer.
- Young dogs with osteosarcoma tend to have shorter survival times and more aggressive disease than older dogs with osteosarcoma.
- Elevations of "Alkaline phosphatase," one of the enzymes screened on a basic blood panel, bode poorly. These dogs have approximately 50% of the survival times quoted below for each protocol.

CISPLATIN (given IV every 3-4 weeks for 3 treatments)

- The median survival time with this therapy is 400 days.
- Survival at one year: 30-60% (depending on what??)
- Survival at two years: 7-21%
- Giving less than 3 doses does not increase survival time (i.e. if one can only afford one or two treatments, it is not worth the expense of therapy)
- Cisplatin can be toxic to the kidneys and should not be used in animals with pre-existing kidney disease.

CARBOPLATIN (given IV every 3-4 weeks for 4 treatments)

- Similar statistics to cisplatin but carboplatin is not toxic to the kidneys and can be used if the patient has pre-existing kidney disease.
- Carboplatin is substantially more expensive than cisplatin.

DOXORUBICIN (Adriamycin) (given IV every 2 weeks for 5 treatments)

- The median survival time is 365 days.
- 10% still alive at two years.
- Toxic to the heart. An ultrasound examination is needed prior to using this drug as it should not be given to patients with reduced heart contracting ability.)

DOXORUBICIN AND CISPLATIN IN COMBINATION (both given IV together every 3 weeks for 4 treatments)

- 48% survival at one year
- 30% survival at two years
- 16% survival at three years.

There is some interesting and potentially promising new research being done with the drug Artemisinin and dogs with bone cancer. Please see our [Herbal page](#) for more details.

AXIAL OSTEOSARCOMA

While osteosarcoma of the limbs is the classical form of this disease, as previously mentioned, osteosarcoma can develop anywhere there is bone. "Axial" osteosarcoma is the term for osteosarcoma originating in bones other than limb bones, with the most common affected bones being the jaws (both lower and upper). Victims of the axial form of osteosarcoma tend to be smaller, middle-aged, and females outnumber males 2:1.

In the axial skeleton the tumor does not grow rapidly as do the appendicular tumors thus leading to a more insidious course of disease. The tumor may be present for as long as two years before it is formally diagnosed. An exception is osteosarcoma of the rib, which tends to be more aggressive than other axial osteosarcomas.

Treatment for axial osteosarcoma is similar to that for the appendicular form: surgery followed by chemotherapy. There is one exception, that being osteosarcoma of the lower jaw. Because of the slower growth of the axial tumor and the ability to remove part or all of the jaw bone with little loss of function or cosmetic disfigurement, it has been reported that 71% of cases survived one year or longer with no chemotherapy at all.

OTHER

In the May 2002 article, "Gene Therapy Treatment for Canine Cancer," by Karen Earles (Dog & Kennel Magazine), immunotherapy, which activates the immune system to

two-day period when the dog's urine is highly radioactive, it is kept in isolation and monitored by trained medical personnel. After a bone scan, which allows for a more accurate evaluation of the bone and tumor, the dog is released back to the owner. During the following six weeks, the samarium remains within the tumor emitting beta rays that destroy the tumor cells. The danger occurs between the third and sixth week following the samarium treatment when the white cell count drops to a dangerously low level in response to the radiation exposure. Once the white blood cell counts returns to normal, the dog undergoes a series of treatments with the chemotherapeutic drug, carboplatin, to prevent metastasis.

According to Jeanne Young of Harbor UCLA, samarium has potential as a treatment in osteosarcoma. "After baseline laboratory studies, 21 dogs with biopsy proven bone sarcomas (17 osteo, two chondro, one chondro-oste, one synovial) underwent intravenous treatment with Sm-153 EDTMP. Prior to SM 153 EDTMP, one dog had amputation of a limb, cisplatin therapy and external beam radiation, while another had surgery to debulk the tumor. Blood counts were obtained at intervals between one week and two months.

Results: Three dogs with white blood cell (WBC) counts near zero developed sepsis and died within three weeks of treatment. One dog developed transient aplastic anemia at 13 weeks following cisplatin administration. Maximum WBD depression occurred at three to four weeks post Sm 153 EDTMP decreasing to critical levels below $0.5 \times 10^6/\text{mm}^3$, with platelets reaching nadir at three to four weeks. Post treatment survival time, excluding the animals that died from sepsis ranged from three months to one-year with an average survival of 20.2 weeks as compared to 8.7 weeks in prior series without Sm 153 EDTMP. Survival time increased to 19.9 weeks when cisplatin and/or surgery followed SM-153 EDTMP. With the exception of chondrosarcoma all dogs experienced pain relief. Follow up scans using Tc-99m methylene diphosphonate were performed after three months in five of 13 surviving dogs. Tumor uptake decreased in three of the five and remained stable in the other two following therapy. After high dose Sm-153 EDTMP pain palliation was apparent in all dogs with osteosarcoma. A small percentage of sarcomas may show long-term survival with Sm-153 EDTMP. Chondrosarcomas were unaffected. Myelosuppression was severe but transient in most." ("Ethylenediaminetetramethylene Phosphate *SM-153 EDTMP) in the treatment of bone sarcomas, J.C. Young, F.S. Mishkin, May 1999)

Jeanne Young said it is important to treat with Sm-153 EDTMP again in six months and then annually thereafter. She believes external beam radiation--at least three treatments before treating with Sm-153 EDTMP-- increases the odds of survival. One of Jeanne's patients, a Doberman pincher, was doing well after three years. Samarium is no longer offered at Harbor-UCLA, but a new study at the University of Missouri, headed by Dr. Carolyn Henry and funded by Morris Animal Foundation is underway.