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Summer 2015 ■ Volume 9:2 ■ angell.org ■ facebook.com/AngellReferringVeterinarians

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XANTHOMA: THE OTHER FATTY SKIN MASS	MECHANICAL VENTILATION: INDICATIONS AND OUTCOMES	ELBOW REPLACEMENT IN DOGS	ANGELL CELEBRATES 100 YEARS	IDIOPATHIC HYPERCALCEMIA
				
PAGE 1	PAGE 1	PAGE 4	PAGE 6	PAGE 8

PATHOLOGY



Xanthoma: The OTHER Fatty Skin Mass

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When fatty tumors are mentioned, lipoma is typically what comes to mind. However, there is another, less common fatty tumorlike mass known as xanthoma that should be considered, especially when evaluating birds with one or more skin masses. In this brief article, xanthomas in birds, cats, and dogs will be reviewed with a special focus on the use of cytology and histopathology to diagnose this unique entity.

Xanthomas (also known as xanthomatosis or xanthogranuloma) appear as discrete yellow nodules, plaques, or thickenings in the skin (Fig. 1, page 2) that can increase in size over time and be locally invasive. The non-neoplastic masses are composed of cholesterol, cholesterol esters, and other lipids that induce a granulomatous inflammatory reaction at one or more sites. Xanthomas have been reported in psittacine and gallinaceous birds, with single case reports in a goose, an American kestrel, and a great white pelican. They are relatively common skin masses in cockatiels and female budgerigars. In addition to birds, xanthomas have been described in humans, cats, dogs, horses, amphibians, and reptiles. The most common cutaneous sites observed in birds are wings, dorsal cervical region, sternum, back, ventral abdomen, and uropygial area. Although they are most frequently observed in the skin, they have also been reported in the conjunctiva, internal structures of the eye, oral cavity, internal organs, tendons/periarticular regions, and remote sites such as bone marrow. In cats,

(CONTINUED ON NEXT PAGE)

EMERGENCY



Mechanical Ventilation: Indications and Outcomes

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Exposure to mechanical ventilation, for many, is limited to one or two experiences in veterinary school. A lot of veterinarians graduate thinking of the ventilator as a “last resort” option because it is often used as a part of end-of-life care to spare suffering when owners are unable to contemplate euthanasia. However, recent literature has shown that when ventilation is applied to the severest forms of reversible respiratory disease, outcomes can be quite favorable. Thus we have learned over the past 15 years that it is the prognosis of the *underlying disease*—not the fact that ventilation was needed—which determines outcomes in mechanical ventilation cases. There are two categories of disease that may require positive pressure ventilation: respiratory failure and pulmonary failure. Respiratory failure implies that the patient’s thoracic excursions cannot adequately eliminate carbon dioxide, while pulmonary failure implies that the lungs are damaged in some way and cannot exchange oxygen properly no matter how hard the pet breathes.

In pure respiratory failure, gas exchange of the lungs is normal, but the patient cannot breathe deeply or fast enough to move gases in and out of the lungs. Many disease processes can cause this problem, and clearly the prognosis is not uniform among them. For example, a dog that cannot breathe due to brain stem herniation from a large intracranial tumor does not have the same prognosis as a dog that is unconscious after ingestion of marijuana! Although not common in this area, a recent

(CONTINUED ON PAGE 10)

PATHOLOGY

they most often occur in periocular and periorbital regions, legs, trunk, or footpads, while in dogs, they typically occur on the face, ears, and ventrum.

The cause of xanthoma formation is not definitively known; however, some predisposing factors are shown in Table 1. Solitary cutaneous xanthomas are often idiopathic. When solitary or multiple cutaneous xanthomas (“xanthomatosis”) are identified in animals, evaluation of the diet for high fat content (especially seed-based diets in birds) and determination of serum cholesterol and triglyceride concentrations are indicated. Cutaneous xanthomas have been reported in cats with primary idiopathic familial hypertriglyceridemia and secondary hyperlipidemia due to diabetes mellitus, glucocorticoid therapy, or progesterone therapy. Xanthomas have been experimentally induced in quails and mice deficient in either apolipoprotein E21 or low-density lipoprotein receptors when fed a diet high in cholesterol. In dogs, cutaneous xanthomas have been reported with hyperlipidemia secondary to diabetes mellitus and idiopathic hyperlipidemia.

Definitive diagnosis of xanthoma requires histopathology. The masses appear histologically as sheets of foamy macrophages and fewer multinucleated giant cells (Fig. 2) interspersed

TABLE 1	PREDISPOSING CONDITIONS TO CONSIDER FOR XANTHOMA FORMATION	
	Hypercholesteremia/hyperlipidemia caused by:	Prior tissue necrosis at the site
	<ul style="list-style-type: none"> • High-fat diet • Disorders of lipid metabolism • Metabolic conditions • Drugs (corticosteroids, progesterone) • Endocrine disorders (diabetes mellitus, hypothyroidism, hyperadrenocorticism) • Idiopathic hyperlipidemia • Pancreatitis 	Prior hemorrhage due to trauma or feather cyst removal
		Exposure to toxic fat-soluble substances (example: chlorinated hydrocarbons)
		Underlying cysts, lipomas, or other tumors

with cholesterol and lipid deposits. Histologic differential diagnosis includes granulomatous inflammation due to infectious etiologies, especially mycobacteriosis. For this reason, special stains and/or molecular diagnostics to exclude fungal and mycobacterial organisms as a cause of the inflammation are generally recommended. Fine needle aspiration for cytologic evaluation is a useful noninvasive method of obtaining a presumptive diagnosis of xanthoma/xanthomatosis. An example of cytologic features typical of a xanthoma

is shown in Fig. 3. The predominant cell type found in cytologic specimens is finely vacuolated (foamy or lipid-laden) macrophages. Multinucleated giant cells and low numbers of neutrophils, eosinophils, lymphocytes, and plasma cells may also be present. The background often has cholesterol crystals and round, clear areas typical of fat droplets. Cholesterol crystals are nonstaining (clear) or pale basophilic staining angular, notched plates that may occur singly or in stacks or clusters.

FIGURE 1

❏ Photograph of a subcutaneous xanthoma excised from the left tibiotarsal region of an 11-year-old male monk parakeet (quaker parrot). In this cross section of an oval, smoothly contoured mass, note the bright yellow color and small foci of red-tan mottling representing areas of hemorrhage and necrosis (black arrows). Photo courtesy of Dr. Pam Mouser, Angell Pathology.

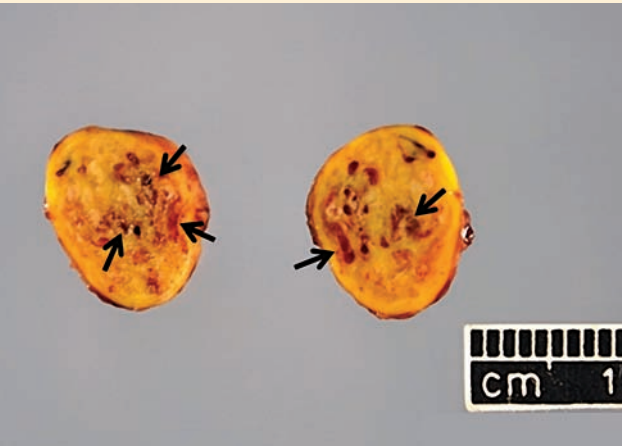
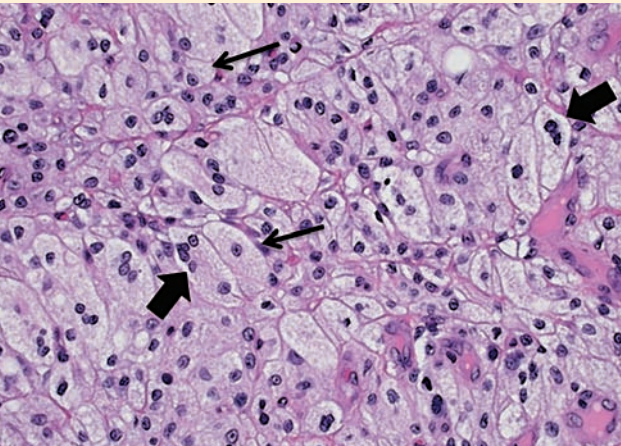


FIGURE 2

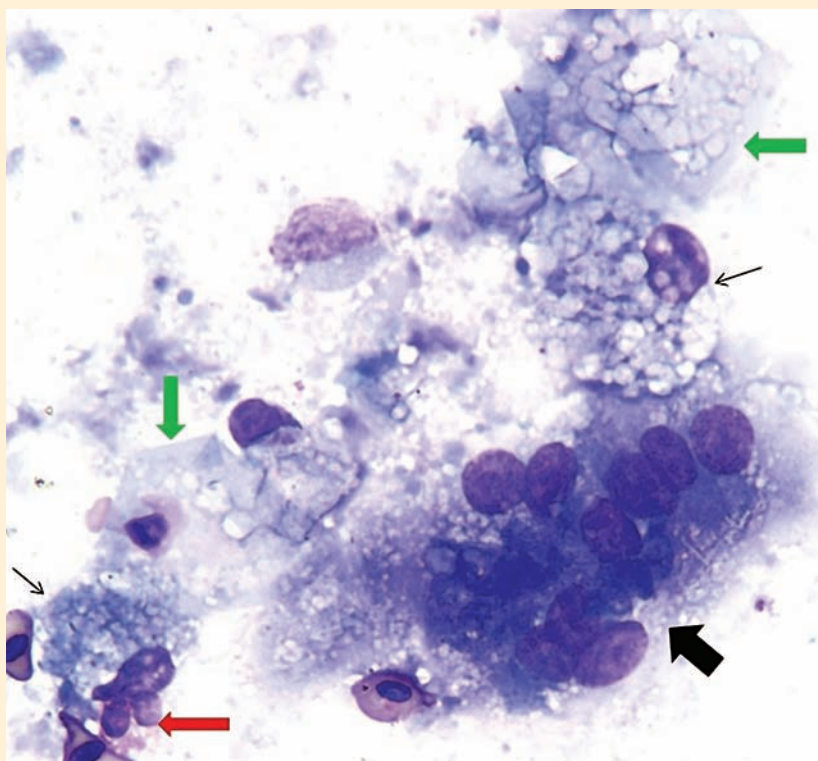
❏ Photomicrograph of a histologic section of an oral cavity xanthoma that was surgically excised from a cat. Note sheets of foamy (lipid-laden) macrophages (thin black arrows) and fewer lipid-laden multinucleated giant cells (thick black arrows). H&E stain. Photo courtesy of Dr. Pam Mouser, Angell Pathology.



PATHOLOGY

FIGURE 3

➤ Photomicrograph of a fine needle aspirate from a subcutaneous mass on the wing of a female green-winged macaw. Note lipogranulomatous inflammation consisting of lipid-laden macrophages (thin black arrows), multinucleated giant cell (thick black arrow), and a heterophil (red arrow). Angular plates representing cholesterol crystals (green arrows) and clear vacuoles representing free lipids are present in the background. 1000x magnification, Wright-Giemsa stain.



The treatment of choice for solitary cutaneous or oral xanthomas that are ulcerated, infected, or large enough to interfere with function is surgical excision. Incomplete excision can lead to recurrence or poor wound healing. In some cases, the extent of tissue involvement and/or the location of the mass may preclude surgical excision. Cautery to control hemorrhage and use of an Elizabethan collar to prevent self-mutilation in birds may be helpful. Smaller, solitary quiescent xanthomas that are not bothering the bird are frequently not excised and just monitored periodically for increase in size. Prior to surgery and especially when multiple xanthomas are present, evaluation for underlying dietary, metabolic, toxic, and endocrinologic disorders

is warranted. Treatment of predisposing conditions including dietary modification may improve xanthomatosis.

For more information, please contact Angell's Pathology service at 617-541-5014 or pathology@angell.org.

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SURGERY



Elbow Replacement in Dogs

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Pull out a veterinary textbook, look up canine elbow dysplasia, and under the prognosis section you'll discover the one word that says it all: "guarded." Elbow dysplasia is one of the most frustrating orthopedic challenges out there, particularly as dogs age and succumb to the inevitable secondary changes brought on by the consequences of a less-than-perfect cubital joint.

Arthroscopy provides an early, excellent opportunity to address many of the fundamental underlying imperfections—the fragmented coronoid process, the humeral osteochondrosis lesion, and the un-united anconeus—regardless of whether we opt for a medical or a surgical approach, degenerative changes *will* take place in the form of osteoarthritis. The goal of periarticular new bone and fibrous scar tissue may prove initially beneficial, reducing and restricting painful motion, but over time, the progressive nature of these adaptive changes can have a severe and debilitating effect and a major negative impact on quality of life.

Pain management has emerged as a vital specialty in its own right, especially in the management of chronic elbow arthritis. But what are your options when you've worked your way through the nonsteroidal anti-inflammatories, the joint supplements, you've tried the physical therapy, the weight control and the holistic approaches? Do we have anything else to offer?

Moseley, an 8-year-old, neutered male Labrador, made me realize that the answer is definitely yes. Moseley presented to Angell with a six-year history of left forelimb lameness that had been getting progressively worse during the last year. He had worked his way through carprofen, gabapentin, tramadol, and Adequan, but chronic lameness and pain were significantly impacting limb func-



tion. His owners were interested to find out if there was anything else we might offer.

From a surgical standpoint, when it comes to end stage elbows, elbow arthrodesis and even amputation are reserved for cases of intractable pain where euthanasia has become a realistic consideration. Now, thanks to recent advances in surgical techniques and available implants, total elbow replacement has become a viable option.

There are many types of elbow replacement systems commercially available, but Moseley underwent a surgery using the TATE system, designed by Dr. Randy Acker and manufactured by Biomedtrix. The system is described as semi-constrained, making use of the exist-

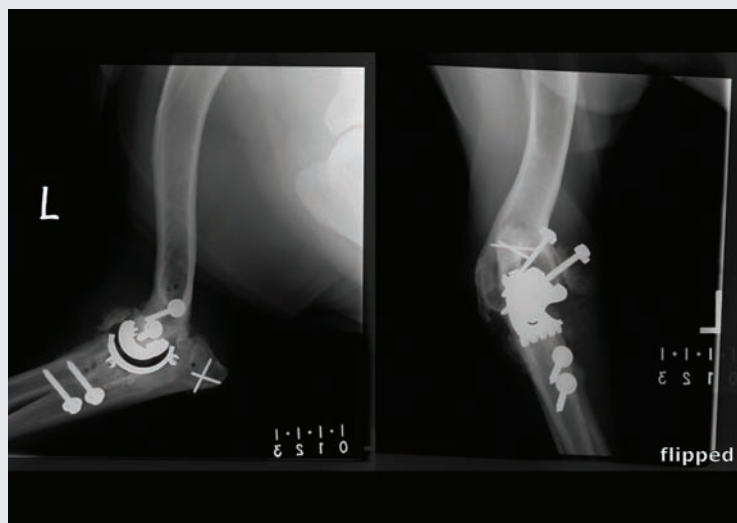
ing joint capsule and implant shape to impart stability. It is non-cemented, employs a bone "milling" technique to increase precision and reduce time, and takes out the problematic micromotion between the radius and ulna by fusing these bones at the time of implantation.

Dr. Acker was kind enough to join me for Moseley's procedure. Like most dogs that undergo this procedure, Moseley was discharged two days after surgery. Exercise restriction is essential for the next two to three months, and physical therapy, especially hydrotherapy, can be highly beneficial to recovery. In an unpublished collection of data from 30 elbow replacements, 95 percent of owners reported a good to excellent improvement in attitude and activity due to

SURGERY

FIGURE 2

➤ Lateral (L) and AP (R) view 10 weeks post left total elbow replacement confirming stable implants, fusion of the radius and ulna, and appreciable decrease in DJD.



reduction in pain. Complications were noted in less than 7 percent of dogs.

The surgical procedure is technically demanding and the implant costs are high. However, the use of non-cemented implants and a medial approach to the elbow, combined with fusion of the radius and ulna, can create an arthroplasty of a challenging joint capable of results far more appealing than the grim alternative of elbow arthrodesis or even limb amputation.

If you have questions, contact Dr. Trout at surgery@angell.org or 617-541-5048.

ANGELL WELCOMES NEW STAFF MEMBERS

Angell Animal Medical Center is extremely pleased to announce that Dan Spector, DVM, DACVS has joined our Surgery Service and Abbie Lebowitz, DVM, DACVIM (Neurology) has joined our Neurology Service. Dr. Spector will be practicing at MSPCA-Angell West in Waltham and Dr. Lebowitz will be practicing at both Angell Boston and MSPCA-Angell West.

DAN SPECTOR, DVM, DACVS

Dr. Daniel Spector became a veterinarian because he loves the human-animal bond and enjoys helping owners take exceptional care of their pets. In addition to performing surgery, he enjoys helping clients to understand the disease process, the reasoning behind the procedure and the expected outcome. Skilled in all aspects of surgery including orthopedic, soft tissue and minimally invasive procedures, he is especially interested in wound management and reconstructive surgery.

EDUCATION

- Doctor of Veterinary Medicine, Tufts University, Grafton, MA
- Bachelor of Science, Bates College, Lewiston, ME

SPECIALTY TRAINING

- Residency, Surgery, The Animal Medical Center, New York City, NY
- Internship, Small Animal Medicine & Surgery, Angell Animal Medical Center, Boston, MA

CERTIFICATION

- Diplomate, American College of Veterinary Surgeons-Small Animal

ABBIE LEBOWITZ, DVM, DACVIM (NEUROLOGY)

Growing up, Dr. Abbie Lebowitz had a diabetic cat who, over the years, was cared for by a team of “amazing” specialists. The care and empathy they showed for him inspired her to not only become a veterinarian but to also become a specialist. She feels that veterinary medicine is in a very exciting time, with new surgery techniques and disease treatments being discovered regularly. Dr. Lebowitz is skilled in all aspects of neurology and neurosurgery but is especially interested in epilepsy and immune-mediated diseases of the central nervous system.

EDUCATION

- Doctor of Veterinary Medicine, The Ohio State University, Columbus, OH
- Bachelor of Science, Environmental Science, University of Rochester, NY

SPECIALTY TRAINING

- Residency, Neurology and Neurosurgery, The Animal Medical Center, New York, NY
- Internship, Small Animal Medicine & Surgery, The Animal Medical Center, New York, NY

CERTIFICATION

- Diplomate, American College of Veterinary Internal Medicine-Neurology

Angell Celebrates 100 Years



Angell's original building at 180 Longwood Ave. from 1915-1976.



Angell's Small Animal Operating Room, 1915.



Dr. C. Lawrence Blakely (center), soft tissue surgery pioneer, performs one of the first diaphragmatic hernia repairs. Assisting him is Dr. Todd Munson, (right) Director of Medicine at Angell from 1956-1975. Aide at extreme left employs a bicycle pump to respirate the patient, 1935.

1934

- Angell develops a repair technique for diaphragmatic hernia (overcoming the problem of providing positive pressure ventilation by using a bicycle pump)

1940

- Begun unofficially in the late '30s, Angell introduces the first internship program in small animal medicine and surgery. The first 2 interns begin. The internship is temporarily interrupted by World War II



1940 – Angell's diagnostic laboratory for physical, chemical, and bacteriological tests. Back then, histopathological studies of biopsy material were made by pathologists connected with the neighboring Harvard Medical School; now, we have two full-time, board-certified pathologists on staff.



Original Caption: When Midnight, affectionate and beloved pal of the U.S. Navy Shore Patrol, in Boston, recently complained in his own canine fashion that he wasn't feeling any too well, his devoted masters rushed him to Angell Memorial Animal Hospital, where he was found to be suffering from a slight intestinal disorder. Midnight has seen his share of war, too, for it is said that he originally came from New Caledonia and has already survived two torpedoings. Pictured, left to right, are: George R. Corning, Boatswain's Mate, First Class, and Roy M. Lyons, Boatswain's Mate, First Class, of the Navy Shore Patrol, with Dr. Norma L. Greiner of the Hospital Staff, 1943.

1915

1915

- World War I escalates, American women seek the right to vote, Bostonians celebrate a World Series win with Babe Ruth on the team, and Angell Memorial Hospital opens its doors for the first time on March 1, 1915



Angell's Horse Operating Room, 1915.

1935-41

- Angell is first to study and diagnose a variety of diseases: Osgood Schlatter's disease ('35), Canine hip dysplasia ('37), Legg Perthes disease ('41), osteochondritis disease of the shoulder, and intervertebral disc disease ('41)

1936

- Shroeder-Thomas splints are developed at Angell as a basic method of repairing fractures

1943

- Angell is first to apply techniques of aseptic surgery to small animal medicine and surgery

1945

- Angell becomes the first veterinary hospital to institute 24-hour nursing and veterinary care
- The clinical-pathologic diagnostic laboratory opens

1947

- Angell is first to introduce a professional training program for veterinary nurses

1948

- The Erwin F. Schroeder Surgical Suite is completed, and it includes a recovery ward—a real innovation for a veterinary institution



Operations at Angell, 1958.

1958

- Angell provides the first description of pancreatitis in cats, and recognition that foods containing red-meat tuna may cause it

1959

- Angell builds a first-of-its-kind veterinary intensive-care unit



The small animal exercise yards were located on the roof at 180 Longwood Ave., 1915.



One of Angell's ambulances, 1947.

1930s

1940s–1950s

1915–2015: A Historical Timeline



The new operating suite has areas for preparation of the patient, for the surgery, and for the patient's observation and care during recovery from anesthesia, circa 1964.

1963

- Angell is first to describe autoimmune hemolytic anemia and thrombocytopenia in dogs

1963–64

- The Surgical Suite is remodeled with piped oxygen and suction, and a new scrub area was attached

1964

- Angell is first to diagnose canine systemic lupus erythematosus

1986

- MSPCA-Angell launches the state-wide subsidized Spay/Neuter Assistance Program (SNAP) for low income pet owners who qualify



An ultrasound is performed on a canine patient, 1988.



Construction in progress on the new hospital addition at 350 South Huntington Ave., 2005.

2004

- Angell-Boston installs a new MRI designed specifically for imaging animals—the first in New England and only the second available in the country

2005

- New hospital addition completed at 350 South Huntington

1960s–1970s

1965

- Angell is first to discover the dangerous side effects of medroxyprogesterone, a canine birth control drug (this information was largely responsible for the drug being withdrawn from the market)

1973

- Angell clinicians make groundbreaking feline leukemia discoveries including the horizontal transmission of the feline leukemia virus and the relationship of the virus to the occurrence of other cat diseases

1974–76

- Construction and renovation begins at 350 South Huntington Avenue in Jamaica Plain. Angell moves from 55,000 square feet at 180 Longwood to 91,800 square feet at 350 South Huntington



Angell's new building at 350 South Huntington Ave., circa 1976.

1980s–1990s

1993

- Angell's Drs. Alicia Faggella and Michael Aronsohn publish research on anesthetic techniques for neutering 6- to 14-week-old kittens in JAVMA, vol. 202, No. 1, 1/1/93

1997

- Angell establishes the Cancer Care Center featuring on-site radiation therapy



Drs. James Boulay and Barbara Gores perform the first feline kidney transplant at Angell, 1997.

2000s



Technicians prep a canine patient for an MRI, 2014.

2014

- MSPCA-Angell West opens its doors in Waltham, providing 24/7 Emergency and Specialty service
- Angell is certified as a "Cat Friendly Practice" by the American Association of Feline Practitioners
- Angell installs a new, state-of-the-art MRI, allowing for higher quality and faster scans
- One of the first canine total elbow replacement surgeries is performed at Angell by Dr. Nick Trout and Sun Valley Animal Center's Dr. Randy Acker, who designed and developed the TATE Elbow system



Idiopathic Hypercalcemia

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Over the last 20 years, an emerging syndrome of idiopathic hypercalcemia has become prevalent in the feline population. Unfortunately, to date, the cause remains unknown. There are those who theorize that the rise of acidifying, magnesium-restricted diets to prevent struvite crystalluria/urolithiasis has had an impact on this relatively new syndrome, but a genetic predisposition has also been suggested.

Many affected cats have no clinical signs, with the hypercalcemia being picked up as an incidental finding on routine blood work. When cats are clinical, the most common signs are vomiting and weight loss. Other gastrointestinal symptoms, such as anorexia and constipation, are also common. Uroliths (typically calcium oxalate) are reported in 10–15 percent of affected cats.

Calcium is present in three fractions in the plasma: ionized, complexed, and protein bound. A routine biochemistry profile measures only total calcium. If the total calcium is high, the first order of business is either to repeat this finding after fasting, or to check an ionized calcium. The ionized fraction is the biologically active fraction. Cats with idiopathic hypercalcemia will have elevations in both total and ionized calcium. If at all possible, the ionized calcium level should be run on a fresh blood sample drawn into a heparinized syringe and analyzed immediately. Exposure to air during transit to an outside lab can result in erroneously low readings.

The most common causes of ionized hypercalcemia in cats are idiopathic hypercalcemia and hypercalcemia of malignancy. Chronic kidney disease is commonly associated with a high total calcium, but ionized hypercalcemia is rare. The most common feline malignancies associated with hypercalcemia are lymphoma, multiple myeloma, and squamous cell carcinoma.

When presented with a hypercalcemic cat, the optimal workup would include a thorough dietary history and PE, as well as a CBC, serum biochemistry profile, T4 (middle-aged and geriatric cats), urinalysis, chest radiographs, abdominal ultrasound, PTH and PTHrp levels, and possibly measurement of Vitamin D₂ (25-hydroxyvitamin D). In the case of hypervitaminosis D, elevated serum phosphorus level would also be expected.

Even if a complete workup cannot be performed, the clinical history and condition of the cat should provide useful information since cats with hypercalcemia of malignancy are likely to be much sicker than cats with idiopathic hypercalcemia.

Idiopathic hypercalcemia is a parathyroid independent hypercalcemia, so PTH levels are expected to be low or low normal in these cats. If the PTH level is above the midpoint of the reference interval, then a primary hyperparathyroid state should be suspected, and imaging of the parathyroid gland considered. PTHrp levels can be elevated in the face of malignancy. However, the absence of a positive PTHrp does not rule out malignancy.

Once a diagnosis of idiopathic hypercalcemia has been made, treatment options must be considered. Fortunately this disorder is typically associated with a slowly progressive course, so urgent interventions are rarely if ever needed. It is important, however, to consider the particular clinical manifestations of the individual cat being treated. We do see this syndrome concurrently with renal disease. In these cases, renal mineralization is more of a concern, especially if the calcium phosphorus product exceeds 70. Additionally, in cats with uroliths, it is more urgent to resolve the hypercalcemia more quickly to prevent further urolith formation.

Dietary therapy is a reasonable starting point in mildly affected cats. The types of diets that have proven successful in resolving the

hypercalcemia for some cats include high-fiber, renal, and stone prevention diets.

High-fiber diets may result in increased binding of intestinal calcium and therefore decreased calcium absorption.

Prescription renal diets are lower in both calcium and phosphorus and are less acidifying than maintenance diets. Alkalinization may cause decreased bone resorption, resulting in less calcium release. However, the phosphorus restriction may result in increased calcitriol synthesis by the kidney, which promotes calcium absorption. Renal diets are of course also protein restricted, so they may not be an optimal choice for a young adult cat. These would be a good choice for cats with concurrent CKD.

Diets to prevent calcium oxalate uroliths are calcium restricted and promote a neutral urine, so may also be useful, especially for cats in which uroliths have already been detected.

Mark Peterson, DVM, DIP, DCVIM, reknown endocrinology expert, specifically recommends a canned food diet that is high in protein (40–60 percent) and low in carbohydrates (less than 15 percent), without any added urinary acidifiers, and one that is not magnesium restricted.

In mildly affected cats it is reasonable to use dietary therapy alone for four to eight weeks to see if the calcium will normalize. In my experience, the levels wax and wane in some cats without any intervention, so if the degree of hypercalcemia is mild and the cats are clinically normal, I will often just monitor the ionized calcium over time before doing anything.

Once dietary therapy has failed, pharmacologic intervention is attempted. The use of bisphosphonates has become popular, with oral alendronate (Fosamax) being the most

FIGURE 1

⚡ The use of bisphosphonates has become popular, with oral alendronate (Fosamax) being the most commonly used.



commonly used. This drug inhibits bone resorption through inhibition of osteoclasts. It is important to note that use of this drug in cats is still considered investigational, and it should be used cautiously in cats with renal disease.

The starting dose is 10mg per week, and this can be increased to 30mg per week as needed. Alendronate has very poor oral bioavailability, so it is important to administer the medication after a 12-hour fast. Additionally, due to concerns for esophageal erosions as reported in humans, the pill should be followed by a water chaser and/or butter rubbed on the cat's nose or lips to promote licking and salivation, thereby reducing esophageal transit time. Compounding pharmacies can also dispense this as a liquid suspension.

Once started, ionized calcium should be rechecked after one month, and then the dose can be adjusted as needed.

Glucocorticoids can also be used to treat the hypercalcemia. They reduce bone resorption as well as reducing intestinal calcium absorption and increasing renal calcium excretion. The typical starting dose is 5mg of prednisolone once daily, but some cats may need as much as 20mg per day. Negative side effects with long-term use can include iatrogenic diabetes mellitus and muscle wasting.

Hopefully ongoing interest in this syndrome will lead to studies that elucidate the underlying cause of the hypercalcemia, which will in turn allow optimization of treatment.

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For more information, please contact Angell's Internal Medicine service at **617-541-5186** or internalmedicine@angell.org.

COMPLIMENTARY CALL SERVICE & EMERGENCY REPORTING

ANGELL DIRECT CONNECT PROGRAM

We are pleased to offer our Angell Direct Connect after-hours call service to referring partners. This free service expedites your clients' ability to reach a live operator during an emergency and promptly provides you with call information to keep you informed of your patients' needs.

This program enables better service for both you and your clients in the following ways:

- 📞 Client does not need to hang up the phone after receiving the voice message at your practice; instead, they can just press a number and connect to Angell Boston.
- 📞 Live person answers the phone to immediately assist your client (no phone tree).
- 📞 The morning reporting information we provide to you, the referring doctor, allows you to preemptively reach out to your client the following day.
- 📞 The information will provide you with statistics regarding after-hours call volume for your practice and demand for services.

To sign up for this program, please call Mary Grace at **617-541-5181**.

EMERGENCY

Continued from page 1

Mechanical Ventilation: Indications and Outcomes

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Australian study revealed that 75 percent of dogs undergoing mechanical ventilation for tick paralysis or paralytic snake bite (Elapidae) envenomation survived to discharge (when those euthanized for cost reasons were excluded). Tick paralysis as well as Elapidae envenomation are completely reversible diseases that lead to respiratory arrest.

Other reversible diseases that can lead to respiratory arrest may have similarly good outcomes with mechanical ventilation. These include severe marijuana intoxication, opioid drug overdose, botulism and tetanus, hypokalemia, and anesthetic overdose or extreme sensitivity. Other more serious diseases that lead to respiratory arrest or hypoventilation may also benefit from mechanical ventilation. These include cervical intervertebral disc disease and flail chest after thoracic trauma as well as post-operative hypoventilation following thoracotomy. In the case of these diseases associated with severe pain, mechanical ventilation can be not only life sustaining, but part of the analgesic plan as well. This is because the ventilator can be set to breathe faster instead of deeper to spare the pain of movement with rib fractures, and the opioids required to sedate animals to accept mechanical ventilation are analgesic themselves.

A more serious indication for mechanical ventilation is pulmonary failure. In this case, the patient may have a normal CO₂ level, but cannot oxygenate adequately. The most reversible forms of pulmonary failure include pulmonary contusions, non-cardiogenic edema from drowning or strangulation, congestive heart failure, and some forms of pneumonia. An older study (2000) of dogs with pulmonary contusions severe enough to require mechanical ventilation showed that 50 percent of these dogs survived to discharge. A more recent study looking at severe congestive heart failure cases requiring mechanical ventilation revealed that in cases after 2005, 75 percent of the dogs survived to discharge (67 percent of all dogs in the study). Given that early mechanical ventilation studies looking at patients requiring mechanical ventilation for myriad diseases quoted 20 percent overall survival, it's evident that survival rates have dramatically improved, thanks to choosing potentially reversible diseases to ventilate as well as improvements in care.

FIGURE 1

➤ A patient at Angell Animal Medical Center receiving mechanical ventilation after successful cardiopulmonary-cerebral resuscitation. He was later discharged after a full neurologic recovery.



Mechanical ventilation represents the most aggressive form of respiratory support, and often is employed in diseases many vets consider terminal. As veterinary ventilation techniques were developed in the 1990s and early 2000s, mechanical ventilation was reserved for such cases and often the patients did not survive. This is likely due to a combination of severe disease and a necessary learning curve. Acute respiratory distress syndrome, a severe form of lung disease, is often thought of as universally fatal in animals, but a recent case report documents two veterinary survivors—raising the hope that as we select for reversible underlying causes (such as pneumonia or thoracic trauma) and our ability to ventilate very diseased lungs improves, survival rates will improve.

Recently at Angell Animal Medical Center in Boston, a cocker spaniel suffering a cardiopulmonary arrest was resuscitated, mechanically ventilated in the post-arrest period, and then discharged with a full neurologic recovery (Fig. 1). Cases such as these illustrate that this tool, once thought of as a terminal exercise, can be lifesaving when cases are selected carefully and well-trained individuals prescribe and monitor ventilator care.

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