

*Lions and Tigers and Servals, Oh My: Basic Medicine and Husbandry of Non-Domestic Cats :
Non-Domestic Cat Husbandry and Medicine*

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Taxonomy

Order Carnivora

Family Felidae

There are at least 35 species of felids in 3 subfamilies

Subfamily Acinonychinae (1 genus)

Subfamily Pantherinae (4 genera)

Subfamily Felinae (12 genera)

The more common non-domestic cats include:

Subfamily Acinonychinae		
Genus: <i>Acinonyx</i>		
	Cheetah	<i>Acinonyx jubatus</i>
Subfamily Pantherinae		
Genus: <i>Panthera</i>		
	Common name	Scientific name
	Tiger	<i>Panthera tigris</i>
	Lion	<i>Panthera leo</i>
	Leopard (7 subspecies)	<i>Panthera pardus</i>
	Jaguar	<i>Panthera onca</i>
Genus: <i>Pardofelis</i>		
	Marbled cat	<i>Pardofelis marmorata</i>
Genus: <i>Neofelis</i>		
	Clouded leopard	<i>Neofelis nebulosa</i>
Genus: <i>Uncia</i>		
	Snow leopard	<i>Uncia uncia</i>
Subfamily Felinae (12 Genera)		
Common Examples		
	Common name	Scientific Name
	Cougar/mountain lion/puma	<i>Puma concolor</i>
	Serval	<i>Leptailurus serval</i>
	Bobcat	<i>Lynx rufus</i>
	Canadian lynx	<i>Lynx canadensis</i>
	Caracal	<i>Caracal caracal</i>

	Ocelot Margay Jungle cat Jaguarundi Pallas' cat Geoffroy's cat	<i>Leopardus pardalis</i> <i>Leopardus wiedii</i> <i>Felis chaus</i> <i>Herpailurus yaguarondi</i> <i>Otocolobus manul</i> <i>Oncifelis geoffroyi</i>
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HUSBANDRY HOUSING

Most of the more common species of big cats adapt well to captive situations and will thrive if offered adequate space, hiding areas, and enrichment.

- Space
The USDA space requirements call for enclosures to be constructed and maintained so as to provide sufficient space to allow each animal to make normal postural and social adjustments with adequate freedom of movement.

The space and its furnishings should be appropriate for each species. This means that arboreal species, such as leopards, should have an enclosure that is tall enough to allow them to climb and to rest on an elevated branch or platform. Cheetahs should have access to large pens in which to exercise. Species that typically like to swim, such as tigers, should have a pool available. Primary "night quarters" should be large enough for the animals to walk around the enclosure, lay down fully without contacting the sides of the enclosure, stand on their rear legs, and ideally should have an elevated resting platform. Large exercise areas must be available to big cats, even if only for a few hours each day. Smaller facilities or traveling facilities may only have one large exercise area through which the resident cats may rotate on a daily basis.

- Shelter
Shelter must be provided to protect the animals from inclement weather or the extremes of heat or cold. Shelter, in the form of a sturdy den box, may double as an elevated resting area for the cats.
- Enrichment
Enrichment comes in a variety of forms. Simple enrichment items may be logs for scratching or pools for swimming, and an elevated resting area. Arboreal species such as leopards will utilize elevated branches for their elevated resting spot. Toys should be carefully chosen and need to be indestructible. Old tires or nylon ropes may be dangerous choices for enrichment for big cats, as portions could be ingested, resulting potential foreign body impactions and a possible emergency situation. Hard plastic "Boomer" balls are indestructible and make safe, excellent toys for big cats. Other enrichment may involve providing new scents into the environment, or bringing in new furnishings, such as new plant cuttings, tree branches, logs, or clumps of grass. Consider the environment in which that species would normally live. Enrichment may be items offered that may be found in their natural environment, such as providing artificial snow for a snow leopard, or heavy foliage to a leopard.

Training also serves as a form of enrichment for all cats. Some facilities have experienced trainers who have direct contact with the cats. Other facilities have their cats in a protected contact situation. In either case there are simple training methods that would provide enrichment in the form of having different things to "do" each day. Sterile environments with nothing for the cats to do should be avoided.

- Substrate

Footings is especially important for the big cats, and housing them on natural substrates or wood is superior to keeping them on concrete. Big cats may weigh anywhere from 40 to over 250 kg. Jumping down from a den box or shelf repeatedly over a period of years will take its toll on bones and joints if the cat is housed on a hard surface. Placing wood platforms in strategic places such as in front of a gate where big or small cats may pace is always better than having them directly on concrete. Even when the cats are housed on smooth concrete any amount of pacing will cause pad wear or foot lesions over time. Wood platforms will need to be replaced with some frequency depending on how much the individual cat claws at the surface; however the wood may be considered enrichment, as cats like to sharpen their claws.

Dirt or grass floors may be better for the bones and joints of the big cats, however these exhibits are more difficult to clean and sanitize, and some may become muddy during the rainy season and could possibly harbor insect larvae. Pouring a concrete slab may be one solution to that problem however, placing a cover over the area and providing drainage so that rain water runs around it may be another viable solution. Sand or fine gravel, which offer reasonable drainage, and other soft substrates have been used for big cat enclosures with success.

- Fencing

Housing non-domestic cats properly may be a challenge. Fencing should be designed to be strong enough to safely hold the species if hit with full force. Presently there is no written USDA standard for fence height other than it must be appropriate for the species. Tigers have been seen jumping as high as twelve feet in the air and some have escaped from enclosures with 12-foot-high walls. Many curators at larger facilities agree that tigers and lions require fencing height for big cats in excess of 14-16 feet high to safely contain them. A good method to further ensure the containment of these animals is to build a cantilevered "kick-in" at the top of the enclosure fence which would prevent an animal from being able to pull itself up over the top of an enclosure fence. Kick-ins may help to prevent escapes when fencing is only 12 feet tall. Many institutions house tigers and lions behind an 18-foot-tall reinforced cyclone fencing with kick-ins at the top, or the cats are housed behind a wide moat. Small and medium-sized cats (such as cougars and bobcats) will usually require a complete top to their housing, as they are excellent climbers and jumpers. Elements inside the enclosure such as trees, logs, or denboxes, should be located a good distance (15 feet or greater) from the enclosure fence so the animals cannot use them to get over the fence.

Natural exhibits with a variety of elevations are pleasing to both viewer and cats alike. Adding elements such as waterfalls or natural plants and logs is desirable. Simple night

quarters are acceptable if the cats are allowed to rotate out to an exhibit or exercise area or go for daily walks with their trainers.

Keeping the public back a safe distance from the enclosure is always a good idea, especially for unmanned exhibits. Protecting cats from the public and vice versa is important in public display situations.

SAFETY PROTOCOLS

Institutions that house big cats should have specific training protocols for new keepers/volunteers, or in some instances, new trainers.

These protocols should include:

- Lock-check protocols, and supervision of lock-checking
- Cage to cage transfer protocols; which allow personnel to move cats from one cage to another to facilitate cleaning
- Cleaning protocols
- Feeding protocols
- Trainer apprentice programs for new trainers to follow to ultimately safely work with big cats
- Back-area protocols: rules for non-staff public to visit "behind the scenes"

ESTABLISHING ESCAPE PROTOCOLS AND CRISIS MANAGEMENT

- How will communication between experienced personnel occur if a cat escapes?
- Write a radio protocol and ensure there is a method of clear communication between staff during an escape
- Is there a trained capture team? A sharp shooter rifle team? How often do they do escape exercises/scenarios?
- What is the availability of these people?
- Is there an experienced veterinarian available for escape emergencies?
- What capture equipment is available?
- How is the staff trained to use the capture equipment?
- Is there a rifle on the premises? If not, where is the closest rifle capable of killing a lion or tiger?

RESOURCES FOR CRISIS MANAGEMENT

The American Association of Zoo Keepers has a crisis management document that is a worthwhile reference and is titled "Resources for Crisis Management in Zoos and Other Animal Care Facilities" edited by W.K. Baker, D.L. Guerrero and S.D. Chan The chapter "The Weapons Response to a Zoological Crisis Situations" describes appropriate weapons to kill a dangerous lion or tiger.

Rifles recommended in the AAZK document deemed appropriate for killing a lion or tiger:

- > .30-06 rifle
- > .300 or .375 H&H
- > .458 Winchester
- > .416 Rigby

Overview of Cat Nutrition

Cats are obligate carnivores. They derive most of their energy requirements from protein. The natural diet of cats is rich in proteins and therefore cats had no evolutionary need to synthesize as many amino acids as omnivores did. They have an absolute requirement for protein, and cannot synthesize the amino acids taurine, arginine, methionine and cystine. Meat diets will provide these amino acids, however diets that contain more carbohydrates may be deficient.

All-meat diets pose potential problems, however. A Calcium:Phosphorus ratio imbalance may lead to growth problems or metabolic bone disease. The Ca:P ratio in the body is 2:1. The Ca:P ratio to aim for in the diet is between 1:1 and 2:1. All-meat diets are high in phosphorous and have little-to-no calcium. They also may be lacking in vitamins A, E and D, which are found in adipose or organ tissues.

Vitamins B and K are provided by gut contents of whole prey and would be lacking in an all muscle-meat diet. Organ meats such as liver, kidney and heart tend to have the worst ratios of Ca:P and may run as high as 1:44.

Dietary Requirements

According to the AZA Nutritional Advisory Group (NAG) Tiger and Cheetah Nutrition Food Preparation and Feeding Guides (found at www.nagonline.net):

Commercially prepared feline diets or properly supplemented carcass meat should be considered the dietary staple for cheetahs or tigers. These guidelines may also be considered adequate for all non-domestic cats. Composition should closely adhere to the National Research Council's recommendations for dietary composition parameters for domestic cats. The research conducted in tigers (Dierenfeld 1987, MacDonald et al 1984, Hackenberger et al 1987) and reviews of felid nutrition for cheetahs suggests that the domestic cat remains the best model for establishing dietary composition parameters for both cheetahs and tigers. Both recommend the addition of the amino acid taurine to heat processed diets, and keeping the levels of Vitamin A to a maximum of 15,000 IU/kg (dry basis) (approximately 25,000 IU/kg wet weight basis), as some studies have shown some zoo felids to have excesses of vitamin A and deficiencies of taurine. No vitamin supplements should be necessary with properly formulated and stored commercial diets. NAG used this commercial diet analysis as an example of a well-balanced diet for the tiger (all values are measured on a wet weight basis):

Crude Protein	19.0%	(min.)
Crude Fat	12.0%	(Min.)
Crude Fiber	1.5%	(Min.)
Ash	4.5%	(Max.)
Calcium	0.6%	(min.)
Phosphorus	0.5%	(min.)
Moisture	62.0%	(max.)
Vitamin A	7,500 IU/lb	(min.)
Vitamin D	850 IU/lb	(min.)

Comment: While 12% fat in the diet may seem acceptable for active big cats, it is likely too much for the more sedentary cats, and limiting the total fat content of the diet to 5-10% seems more optimal for most captive big cats.

The example for a recommended commercial preparation for cheetahs is (wet weight basis):

Crude Protein	19.0%	(min.)
Crude Fat	7.0%	(Min.)
Crude Fiber	1.5%	(Min.)
Ash	2.5%	(Max.)
Calcium	0.6%	(min.)
Phosphorus	0.5%	(min.)
Moisture	69.0%	(max.)
Vitamin A	2,500 IU/lb	(min.)
Vitamin D	750 IU/lb	

Both the cheetah and tiger NAG nutritional guides recommend fasting the animals one to two days a week, and providing shank or other large bones on those days. Feeding femur bones, oxtails, or rawhide has the additional function in promoting periodontal health.

An excellent discussion of nutrition in domestic cats may be found in JAVMA 221(11):1559 - 1567. Dec 1, 2002 "The Carnivore Connection to Nutrition in Cats."

In this article the specific nutrient requirements for cats are outlined. Because cats are obligate carnivores they have nutritional and physiologic adaptations that are different from dogs and other omnivores. Unlike omnivores, cats have not developed many of the metabolic pathways for processing higher carbohydrate diets. Due to a reduced activity level of the enzyme hexokinase, there is minimal hepatic glycogen synthetase activity. The net effect of this is poor conversion of glucose to glycogen and the excess glucose not used for energy will be stored as fat. Thus cats fed high carbohydrate, low protein diets may become obese. This applies to big cats if they are fed diets that contain carbohydrates. Commercial dry cat foods usually contain moderate to high levels of carbohydrates and may predispose cats of all sizes to obesity.

If an all muscle-meat or a muscle and organ meat diet is fed, the diet must be supplemented with some form of calcium.

To supplement 1000 g of meat (1 kg or 2.2 lbs)		
Source	% Ca	(g)
Calcium Gluconate	9	40
Dicalcium phosphate	27	30
Tricalcium phosphate	39	12
Calcium carbonate	40	12

Vitamin Requirements

Cats have increased requirements (relative to omnivores) of water-soluble vitamins. They have requirement for niacin (vitamin B-3) because of a low conversion from its precursor tryptophan.

They also have a requirement for Vitamin D. They have requirements for pre-formed vitamin A as cats cannot utilize carotenes, however carotenoids are still important in their diet. Balanced commercial diets should contain all of the necessary vitamins. See "Nutritional Disorders" below.

What to feed:

There are many opinions as to which diet to feed non-domestic cats. Whole prey would be the most natural diet, however it is usually not the most practical method of feeding. According to USDA Policies for Nutrition for Large Felids, diets must be wholesome, palatable and free from contamination. USDA recommends the use of commercially prepared diets for feeding non-domestic cats, but does not specify any particular brand.

Examples of frozen meat diets from four major commercial companies that produce specialty diets for exotic carnivores are; Dallas Crown Horse Meat-Based Frozen Carnivore Diet, Nebraska (Animal Spectrum Inc.) Premium Canine and Feline Diets, Milliken Toronto Zoo Feline and Canine Diets, and Natural Balance Zoo Carnivore Diet. Frozen meat diets are usually the diet of choice at most zoos and larger institutions. Dry diets have been shown to be nutritious, but cats may shun them due to their texture or palatability. Mazuri (Purina) and Eukanuba have proven to be acceptable dry diets for exotic cats.

Sources of Commercial Cat diets:

Dallas Crown (presently not producing diets for big cats):
(972) 932 3436 <http://www.dallascrown.com/>
Kaufman, Texas

Milliken Meat Products: (416) 299 9600
Scarborough, Toronto, Ontario Canada

Nebraska Brand: (877) 900 3003
North Platte, Nebraska

Natural Balance: (800) 829-4493 <http://www.naturalbalanceinc.com/>
Pacoima, California

Eukanuba (IAMS Company): (800) 863-4267 <http://www.iams.com/>
Dayton, Ohio

Mazuri (Purina Company): (800) 227-8941 <http://www.mazuri.com/>
St. Louis, MO

How much to feed:

A general rule is to feed adult small and medium sized cats (up to 40 kg body weight) 4 to 8 percent of their body weight daily. Large cats require only 1.5 to 3 percent of their body weight in food daily. Young growing cats may require 10 - 25% of their body weight in food each day. These amounts will vary based on the fat content of the diet. Some diets have a higher fat content than others and the feed amounts should be adjusted accordingly. It is best to feed captive cats a

lean diet (less than 10% fat) allowing them the enrichment of eating more food each day, while preventing them from gaining too much weight. Obesity in non-domestic cats is common and should be avoided. Many institutions fast their cats one night each week. The theory behind this is that wild cats do not necessarily eat every day. Offering the cats bones on fast night is enrichment for them and helps to keep their teeth clean. Weekly fasting may help to keep the cats from becoming obese. Offering whole prey such as rodents, rabbits or poultry, or chunk horsemeat one night per week provides variety and dietary enrichment.

Fresh water should be provided at all times. Containers for water must be sturdy and for the larger cats, bite-proof. Stainless steel buckets hooked to cyclone fencing, or concrete bowls or troughs that are difficult to overturn are ideal. Galvanized buckets for medium and large cats are generally a bad idea as most big cats can easily bite through and destroy a galvanized bucket. This could lead to dental problems or at a minimum require water buckets to be replaced on a frequent basis. Some big cats will even destroy the stainless steel buckets, so other containers must be provided.

Nutritional Disorders

Metabolic bone disease

Metabolic bone disease (MBD) may result from feeding a diet with an inappropriate calcium:phosphorus ratio. The calcium should be approximately 1.7 times the phosphorus in the diet. Organ and muscle meat are very high in phosphorus and calcium must be supplemented in appropriate amounts to prevent this problem. Thin bone cortices as well as hairline fractures and intermittent lameness are all signs of metabolic bone disease. Radiographs will confirm the poor bone density. MBD has been seen in young growing exotic felids. A young tiger and a young cougar at one facility were being fed a formula and a commercial diet that reflected a normal Ca:PO₄ ratio on the label, but lacked sufficient calcium in the actual diet. Both affected cubs were being fed the same lot-number of the commercial diet routinely fed to all of the cats at the facility. Both cubs had siblings that had normal bone density. The two cubs suffered multiple hairline fractures in multiple limbs. Once the problem was recognized, the cubs were put on a balanced diet, and were supplemented with a calcium supplement for several months. They both fully recovered. Their siblings were unaffected because they were still nursing a significant amount of the Esbilac formula, which contains a balanced Ca:PO₄ ratio. Neither of the affected cougar or tiger cubs seemed to like the Esbilac formula, thus the majority of their diet was the abnormal commercial meat diet which lacked the appropriate amount of calcium. Privately owned non-domestic cats, especially tigers, bobcats, and lynx, appear to have the highest incidence of MBD. Private owners often feed poor diets such as ground turkey meat or chicken breast to young growing cubs. They fail to supplement the cubs with the appropriate amounts of calcium (see Calcium Supplementation chart above), and the cubs they hand-rear suffer terrible consequences. Remember, it takes about 12 GRAMS of calcium carbonate to balance one kilogram of muscle meat fed.

Vitamin A deficiency has been implemented in causing abnormalities in the cranial bones, especially atlanto-occipital malformation with ankylosis, hypertrophic osteopathy in the occipital bone and parietal bone, and osseous tentorium cerebelli, leading to progressive ataxia in young lions. Most affected lions are between 6 - 15 months of age. Many of the lion cubs exhibiting this syndrome were fed a diet of chicken parts with little other supplementation. Several juvenile

lions thought to have a Vitamin A deficiencies were treated with 600- 1500 IU Vitamin A PO SID and showed significant improvement. While some never fully recovered, others made remarkable recoveries. Some required surgery to correct the problem. (See References) One veterinarian has supplemented as much as 4000 IU Vitamin A/D per day and has seen improvement in young ataxic lions suffering severe clinical signs.

Vitamin B1 (thiamin) deficiency has caused anorexia, ataxia (more pronounced in the rear limbs), hypermetria (more pronounced in the front limbs), progressing to generalized weakness and recumbency lasting several minutes to hours, or longer. Young lions presenting with this problem were often fed a beef muscle meat diet supplemented with calcium. Thiamin deficiency may be diagnosed by assaying enzymes (erythrocyte transketolase) that require thiamine as a cofactor or with a microbiologic (*Lactobacillus fermentum*) thiamine assay. Lions with a thiamin deficiency generally respond positively within a day of initiating a treatment of 3 mg/kg thiamin PO SID, and signs may resolve within four days of initiating treatment. The diet should be immediately changed to a balanced diet containing appropriate amounts of thiamin and other vitamins and nutrients, with additional thiamin supplementation to continue for up to six months. (See References for more information)

Other Diet-Related Problems

Ethylene glycol poisoning has also been seen in cats being fed a particular commercial diet. Several exotic cats around the country were reported to have this problem and each them had been fed diets originating from the same company (but different lot numbers). Aggressive daily fluid therapy was successful in treating one young serval, while another older serval developed renal failure and died. This product also affected a snow leopard and several cheetahs living in other parts of the country.

***Clostridium perfringens* enterotoxigenesis** occurred in two leopards, and it was postulated that feeding the leopards partially thawed meat may have precipitated the problem (Neiffer 2001; See References)

CAPTURE AND RESTRAINT

RESTRAINT

Smaller species of felids may be restrained in a net for brief procedures such as giving injections. Larger species may be restrained in specialized squeeze cages. When designing a new facility, adding a squeeze cage into a runway between two enclosures is one method to get animals into the squeeze cage with a minimal amount of stress.

Many species of non-domestic cats may be trained to allow for a variety of medical behaviors including venipuncture and auscultation of the lungs and heart. Some older cats with chronic renal problems have allowed sub-cut fluids to be given on a regular basis with no restraint. Many trained or tractable cats (both large and small species) will allow vaccinations and even anesthesia drugs to be given using a hand-injection technique.

Many smaller species of cats may be crate-trained and will enter an airline or transport crate on command. This is useful if the animal needs to be transported between exhibits, or to bring the cat to the veterinary facility.

ANESTHESIA

Non-domestic cats are fairly straightforward to anesthetize. Common injectable agents include:
ketamine / xylazine;
ketamine,/xylazine/ valium,
ketamine/valium,
ketamine / medetomidine;
medetomidine;
tiletamine-zolazepam (Telazol)

Pre-Anesthesia

Cats should always be fasted at least 12 hours, and ideally 24 hours prior to anesthesia. Water may be provided prior to anesthesia. Immobilizations should be planned to occur during the coolest part of the day if done in a region or time of year where the ambient temperatures are high, and the procedure must be done outside in an uncontrolled environment. If high temperatures are expected, ample cool water should be on hand to help to prevent or manage hyperthermia.

Emergency Equipment

This equipment should be readily available for all immobilizations.

Endotracheal tubes with inflatable cuffs (sizes 14, 16, 18 mm for adult tigers, and up to 26 mm for adult male lions)

Ambu bag

Oxygen (if practical)

Stomach tubes and funnel - for cold water enemas in cases of hyperthermia.

Emergency Drugs

Doxapram- for respiratory depression or arrest-(commonly used) Effective dose range 0.2-0.5 mg/kg IV or IM for large species and the domestic cat dose (1 - 5 mg/kg IV) for species smaller than 20 kg.

Epinephrine- for cardiac arrest- Dose range 0.5 - 1.0 ml of 1:1000 solution intracardiac using a six inch spinal needle for the larger species. For the smaller species, use the domestic cat dose; 0.05 - 0.5 mg (0.5 - 5 ml) of 1:10,000 solution intratracheally or intravenously. May need to repeat every 5 minutes. If intratracheal or IV sites are inaccessible, the intracardiac (IC) route may be used. IC dose is 0.5 to 5 micrograms/kg (0.0005 to 0.005 mg/kg).

Prednisolone- for circulatory collapse/shock- Dose range 5-10 mg/kg IV.

Dexamethasone- for circulatory collapse- Dose 1 - 5 mg/kg IV.

Yohimbine- An alpha2-adrenergic antagonist that can antagonize the effects of xylazine. Use for respiratory depression or arrest, cardiac arrhythmia or arrest. Use requires ending procedure. Dose range 0.05 - 0.1 mg/kg IV. The cat should become alert within 2 to 10 minutes.

Atipamezole- Alpha2 adrenergic antagonist; antagonizes agonists such as medetomidine or xylazine. Generally used to reverse the effects of medetomidine at a dose of 4 - 5 mg of Atipamezole IM per mg of medetomidine used.

Induction

Most large cats will need to be darted or pole-syringed for induction. Smaller cats may be placed in a crate and induced with gas. Small cats (servals, bobcats, caracals) that have been trained to enter a crate may be anesthetized in an induction chamber or an airline crate that has been covered with a large plastic bag and filled with Isoflurane gas. Once sedated, the cat is removed from the crate and either intubated or masked and maintained on Isoflurane for the duration of the procedure. This method is typically very smooth, and with the exception of needing to deal with a cage full of anesthesia gas (which can be opened and immediately placed outside). The induction and recovery using this method are usually superior to using injectable agents in the smaller species.

Some cats may be trained to allow hand-injections. The blowpipe is a useful method of darting animals at fairly close range. Most cats have night quarters that are small enough to allow the use of a blowpipe dart. Care must be taken to remove or restrict the use of high shelves or den boxes where the cat may jump after the dart hits it. Cats often seek the high point in an enclosure after receiving the injection and may fall during the induction process.

Dosages:

There are many references and acceptable doses of anesthesia drugs for the various species of non-domestic cats. Generally speaking, dosages of drugs that work on domestic cats will also work on the smaller cat species. The difference is that most domestic cats may be hand-restrained for IV induction, whereas most small exotic species will need to be sedated before they can be handled, which may require the use of a dart, an oral sedative, or using a gas induction technique delivered into their crate.

There are several references with large cat anesthesia doses published. Two references are in Dr. Murray Fowler's Zoo and Wild Animal Medicine 2nd or 5th editions (Saunders).

Common drug protocols used for immobilizing large cats (30 kg cougars up to 250 kg lions)

Xylazine (0.2 to 0.5 mg/kg) IM, and Ketamine (3 - 10 mg/kg) IM. Giving the xylazine a few minutes before the ketamine may be useful, however most cats vomit or dry heave 6 - 9 minutes after getting the xylazine. This is usually not a problem but underscores the importance of fasting the cat before the immobilization. The dose of xylazine necessary will depend on the temperament of the cat. Trained cats that are accustomed to people will require a much lower dose than a wild cat or those that are never handled. The dose of xylazine will also affect how

much ketamine is used. In a 200 kg lion, giving 100 mg xylazine (0.5 mg/kg) will reduce the dose of ketamine to about 600 mg. The xylazine may be reversed with yohimbine (0.05 mg/kg IV). Reversal should only occur for procedures long enough for the ketamine to have worn off (generally over 90 minutes).

Xylazine (0.2 to 0.5 mg/kg) IM, Ketamine (3 - 10 mg/kg) IM and diazepam (0.05 - 0.1 mg/kg) IM Same as above but the diazepam (or medazolam 0.1 mg/kg) will generally decrease any occurrence of seizures, and will smooth but somewhat prolong the recovery.

Ketamine (4 - 10 mg/kg) and diazepam (0.1 - 0.5 mg/kg) IM This combination requires a higher dose of ketamine than when xylazine is used, however this seems to be a safe combination when a cat requires daily or frequent anesthetics.

Ketamine (2 - 3 mg/kg) and Medetomidine (0.02 - 0.03 mg/kg) IM May be mixed in the same dart. Medetomidine may cause respiratory depression, hypertension and emesis and should not be given to cats with known cardiopulmonary problems. When using this in 200+ kg cats it would be useful to have the 10mg/ml medetomidine made by Orion Pharma Animal Health (Helsinki, Finland) or Wildlife Pharmaceuticals Inc. (Fort Collins, Colorado) to reduce the dose volume in the dart. Use atipamizole at 4 - 5 mg IM per mg of medetomidine used to reverse the medetomidine.

Medazolam (0.1 mg/kg) and Medetomidine (0.05 - 0.07 mg/kg) and Ketamine (2-3 mg/kg) IM if needed. This decreases occurrence of seizures and decreases the time to recovery. Reverse with 0.25 - 0.35 mg/kg IV or SQ atipamizole. This is the preferred drug combination for large cats at the Henry Doorly Zoo (from TG Curro, Western Veterinary Conference 2002).

Tiletamine/Zolazepam (Telazol) Many do not like this drug combination. Do not use this drug if you are unfamiliar with its use. It does cause seizures in Siberian tigers and Siberian cross tigers, and occasionally in lions 2 - 3 days after the procedure. The seizures are usually severe but can be controlled with valium. Telazol has worked well for me, but because of the potential for seizures a few days later I only use it for one-time anesthetics on Bengal tigers, cougars, and lions. With the exception of cheetahs, if the cat needs to be anesthetized more than once in a 10 day period, I use another drug combination for subsequent anesthetics. Cheetahs do well with this drug and I use 2 mg/kg IM for good immobilization for 45 minute to one hour procedures. This drug worked very well to immobilize an old cheetah in renal failure two to three times a week for over six weeks for fluid therapy.

Tigers and lions that are tractable are given 1.5 - 2 mg/kg IM. Cougars are given 2 mg/kg IM. Recoveries are prolonged but usually very smooth.

Detomidine Orally

There has been a report of using oral detomidine and ketamine for sedation of large and small exotic felids (1999 Proceedings of the American Association of Zoo Veterinarians, p. 47.) Servals were given 0.5 mg/kg detomidine and 10 mg/kg ketamine orally. Most of the cats in the trial became laterally recumbent, and half of the study group required supplemental drugs (ketamine or Isoflurane) to safely handle them. The oral use of detomidine (0.5mg/kg) and ketamine (11.5 mg/kg) was useful in one lion to keep him quiet when he was darted with a low dose of 50 mg tiletamine and 50 mg zolazepam IM, which was sufficient for the examination.

Other drug combinations: There are certainly other drug combinations that have proven useful when anesthetizing large (and small) non-domestic cats. Propofol given IV may be useful in aiding in intubation. As always, watch for apnea when using this drug, and be prepared to immediately intubate.

Isoflurane May be used to maintain cats for lengthy procedures. May also be used via a mask to reduce the amount of injectables. Tigers may be given just enough injectable agent to enable the anesthetist to place a face mask over nose and mouth of the tiger, and allow the cat to become fully anesthetized using the gas. This works best on tractable cats and with experienced personnel, and is a reasonable approach when a large cats needs to be anesthetized daily for a period of time for critical care. This is never a good idea for the inexperienced.

Anesthesia equipment

Anesthesia masks for large cats may be made from cut-off clear plastic gallon containers. Nolvasan bottles work well because the plastic is tough and won't crack. Brittle plastic containers should be avoided. Carving a hole in the lid attachment for the bottle just the size of the anesthetic tubing Y-piece is an acceptable method of attaching the tubing to the mask.

Specialized endotracheal tubes may be ordered (Bivona Inc.) for the larger species. Small tigers (between 100 and 150 kg) usually need a 16 mm endotracheal tube. Tigers and lions between 150 and 250 kg require 16 - 26 mm tubes. Care should be taken to auscultate both lungs after intubation to ensure the endotracheal tube was not placed down one bronchus. Equine tubes may be the correct diameter (26 mm in the case of a tube for a large adult lion), but they are too long. Customized tubes made to order at the appropriate length are preferable.

Anesthesia machines used for larger cats should be able to deliver up to 10 liters of oxygen per minute. Large cats may usually be maintained on most small animal units if the oxygen flow is sufficient. It is useful to have large diameter tubing to better deliver flow of anesthetic gas to larger cats.

Rebreathing bags need to be sufficiently large for the species. Tigers and lions over 120 kg will require a 7 liter rebreathing bag. A 5 liter bag is generally suitable for smaller cats (70 - 120 kg).

Recovery

Cats should be allowed to recover in quiet areas that provide sufficient warmth for the size and species. All water bowls should be removed for the duration of the recovery period. Some cats will exhibit a sour, gagging behavior during recovery. This seems often (but not always) related to the use of atropine during the procedure (presumably the cat has a dry mouth on recovery). Cats should be monitored closely until they are able to sit in sternal recumbency.

VACCINATIONS

None of the vaccines have been approved for, or validated in non-domestic cats.

A general rule is that vaccinations used for domestic cats also work well for non-domestic cats at the same dose.

Fel-O-Vax IV (Fort Dodge) or FVRCP (Mallinckrodt) annually for all large and small exotic cats is a common choice.

Fel-O-Vax PCT is often given to cubs at 4, 6, 9, 12, and 16 weeks. Cubs occasionally get calicivirus lesions from vaccines with modified live calicivirus vaccine. These lesions can be annoying but always seem to resolve with no problems.

It is a good idea to vaccinate all cats housed outdoors with killed rabies virus vaccine (Imrab 3 (Merial) or Rabvac 3 (Fort Dodge)) at four months of age and then every three years. For collections that may be prone to ringworm problems, Fel-O-Vax MCK has been very effective at both prevention of the disease and aiding in the treatment of ringworm.

There may not be any compelling reasons to vaccinate the large species of cats with FeLV vaccine, but smaller species might benefit from this vaccine if they are exposed to domestic cats with the disease. If vaccinating for FeLV, use only a killed virus (Fel-O-Vax LV-K).

Non-domestic cats are susceptible to canine distemper, and have contracted the disease usually from wild animals carrying the disease such as raccoons. There are experimental vaccines available for zoo cats at risk, however there up until very recently there was no commercially available killed canine distemper vaccine available proven to protect cats from this disease. Merial Inc. has produced two vaccines, one that seems promising to protect big cats against canine distemper (Purevax Ferret Distemper Vaccine) and one for rabies virus. These are not killed virus vaccines, but rather live canarypox virus vaccines which carry a portion of the genetic sequence for either rabies or canine distemper virus. These vaccines are labeled for use in ferrets, but will not cause the disease when used in other species because they carry only a fragment of the genetic viral sequence of the distemper virus. The canarypox vectored vaccines have both been used in large cats. The Species Survival Plan (SSP) for Siberian tigers recommends the canine distemper canarypox vaccine be given to all Siberian tigers. Rabies Vaccine by Merial is an alternative to the other acceptable rabies vaccines. Due to the small numbers of non-domestic cats vaccinated with the distemper vaccine, no claims can be made as to the effectiveness or safety of the vaccine. The same might be said of any of the above listed vaccines, however they represent the best known methods of preventing their respective diseases, and they all have been used clinically with no significant adverse reactions reported in big cats.

More information about the Merial vaccines is available from Dr. Montali on the American Association of Zoo Veterinarians website at www.aazv.org in the Medical Information Center, or use this link: http://66.70.134.35/recommendations_for_merial.htm

INFECTIOUS DISEASES

Non-domestic cats are susceptible to all the same diseases that domestic cats can contract. **Feline Leukemia Virus (FeLV)** is a Gammaretrovirus and is rarely reported in non-domestic species, and is probably not a significant pathogen for big cats. Serological surveys of free living mountain lions in California and Florida panthers are negative for FeLV. It is only enzootic in European wildcats in France and Scotland. It has been reported in a captive reared bobcat that was pulled from its mother at 2 days and placed with a surrogate domestic cat. The safety and efficacy of FeLV vaccination in non-domestic felids at risk for exposure should be more fully evaluated.

Feline Infectious Peritonitis (FIP) is caused by a feline coronavirus (FCoV) and is of concern in non-domestic cats, especially cheetahs. The mortality rate of this disease in cheetahs is very high. It has been reported in lions, leopards, cougars, jaguars, lynxes and other cat species, but serious disease is rare in all but the cheetah. Disease varies from subclinical to severe, life-threatening FIP. Both host and virus-related factors influence the severity of the disease. Clinical signs include anorexia, lethargy, abdominal pain, and intermittent diarrhea, and are similar to those seen in domestic cats. Both wet and dry forms occur but usually there is a pleural effusion. The very young and very old cats are most adversely affected.

FCoV is an important contagious pathogen of captive cheetahs. It is prevalent among captive cheetahs. PCR is a sensitive assay for detection of virus shedding, and in one study, one-third of the cheetahs tested were shedding FCoV in feces or had detectable virus in plasma. Not all cheetahs exhibited characteristic FIP disease, but disease consistent with FCoV occurred in four of the six cheetah populations tested. FCoV may be a factor in cheetah GI disease, particularly in those exhibiting vague clinical signs such as abnormal feces, decreased appetite or weight loss. Carrier animals may be an important source of infection through direct or indirect contact with susceptible animals. Serious disease may occur in some cheetahs. Screening with serology only is not ideal, especially if only one serotype is used. Although serology can detect previous exposure to FCoV, PCR is more sensitive for detecting viral shedding.

Diagnosis is complicated because there are two antigenically distinct serotypes of Feline coronavirus (FCoV); Types I and II. Within both these serotypes virulent (FIP) and avirulent biotypes occur. Neither serology nor genetic analysis can distinguish the biotypes so it is not possible to screen for virulent FCoV. Positive coronavirus titers may be seen in non-domestic cats but are often caused by less pathogenic feline enteric coronaviruses (FECV) which generally cause mild self-limiting GI tract disease.

Feline Parvovirus

Autonomous parvoviruses can only replicate in the nucleus of dividing cells and they do not encode a DNA polymerase. Since cellular DNA polymerase is only expressed during mitosis, the first and crucial step of parvovirus replication requires the dividing cell. The age of the infected animal is critical as fetal and newborn tissues are mitotically active. In adults, the lymphatic system and in particular the gut epithelium contain numerous dividing cells and are therefore the main targets of parvovirus infection.

The symptoms of feline parvovirus in animals over three weeks of age are hemorrhagic gastroenteritis, vomiting, lymphopenia or leukopenia. In fetal or neonatal kittens feline ataxia syndrome is seen, where the virus infects the cerebellum causing cerebellar hypoplasia.

Cats are usually infected via the oral route. Virus replication takes place in the epithelium of the pharynx, tonsils and lymph nodes. Virus spreads during the viremic phase to lymphatic organs, peripheral and central lymph nodes, spleen, thymus, and Peyer's patches as well as bone marrow and fetuses. After the viremic phase the virus spreads from cells of the Peyer's patches to highly dividing cells in the small intestine. Lytic infection here leads to loss of gut epithelium and is responsible for the hemorrhagic gastroenteritis syndrome seen with this disease. The disease may

be subclinical with or without mild symptoms. Infection induces a long lasting immunity and complete elimination of the virus.

The epidemiology of feline parvovirus is an acute infection with a high number of virus shed in the feces. Virus shedding ceases after a few days, but the virus can stay infectious in the environment for weeks to months. Transmission occurs through contact with feces from infected animals or feces-contaminated premises, fomites, or personnel.

To diagnose the disease, fecal samples should be collected in the acute phase of disease when fecal shedding is highest. Samples may be tested by ELISA or electron microscopy.

Feline panleukopenia is another name for feline parvovirus and has been described in non-domestic species. This syndrome is also described as feline infectious enteritis, malignant panleukopenia, feline distemper, feline ataxia or spontaneous agranulocytosis. The mortality is high in unvaccinated cats. However the vaccine is very effective and vaccinated cats are unlikely to contract the disease.

Feline viral rhinotracheitis is a feline herpesvirus type I (FHV-1) and is similar in presentation and appearance in non-domestic species as it is in domestic cats. It has been reported in snow leopards, clouded leopards, tigers, lions, jaguars, jaguarundi, and cheetahs.

The pathogenesis is often a systemic disease that affects respiratory tract, conjunctiva, and cornea. The clinical signs include respiratory signs of sneezing, serous or mucopurulent nasal discharge, or oral vesicles or ulcerations; serous or mucopurulent ocular discharge; and may lead to chronic problems such as epiphora, deep chronic ulcers, or keratoconjunctivitis sicca.

Following recovery, the virus can remain latent in trigeminal nerve, cornea and nasal turbinates and may be reactivated during times of stress. Relapses may be seen with a predominance of ocular signs and are common in older cats under conditions of stress.

The killed vaccine is an effective means of prevention in exotic felids.

Feline Calicivirus has been isolated from captive cheetahs, lions and Siberian (Amur) tigers. Clinical disease is rare in cats over 1 year of age. The virus produces vesicular lesions on the muzzle, within the oral cavity, and in the respiratory tract. FCV infection in domestic cats may produce subclinical to acute disease and conjunctivitis, rhinitis, tracheitis, and pneumonia may be seen especially in young kittens. Morbidity is high, and mortality may reach 30% in very young kittens. Clinically the disease cannot be differentiated from feline rhinotracheitis.

Diagnosis depends on laboratory tests. Both viruses can be isolated in cultures of feline cells or may be differentiated by electron microscopy. PCR and serologic tests are available for diagnosis of FCV infections.

Cats recovered from FCV infection or immunized with FCV vaccine appear to remain disease free when further exposed. Annual vaccination is recommended. Cheetahs have been vaccinated with modified live vaccines against FCV and responded better to challenge than cheetahs vaccinated with the inactivated vaccines. Modified live vaccines are not innocuous, and if taken orally (i.e. licking the vaccine site) they may cause acute and persistent disease.

An outbreak of calicivirus affected 5 – 6 day-old Siberian (Amur) tiger cubs and several adult lions and tigers housed in the same area at a Michigan Zoo. The adult felids had been previously vaccinated for calicivirus. Four tiger cubs exhibited moderate to severe lesions with sloughing of the tongue and sloughing of the foot pad epithelium. The adult tigers and lions had oral ulcerations. One lion and one tiger cub died. The source of infection was thought to be from a domestic cat that tested positive for the Feline Calicivirus, and was live-trapped outside of the feline building (Harrison 2007).

Feline Upper Respiratory Disease Complex is caused by a combination of organisms including chlamydia, herpesvirus, and calicivirus. It has been diagnosed in lions, tigers, leopards, cheetahs, and clouded leopards. There is a two to four day incubation period, and the disease is spread by saliva and respiratory secretions. The cat will develop nasal and ocular discharge, and sneezing, salivation, fever, and usually anorexia are seen as the disease progresses. Primary viral pneumonia and death may occur. Secondary bacterial pneumonia is common. Clouded leopards that recover often develop long term infections of the sinuses and nasal turbinates. Infections of the ethmoid plate have occurred.

Feline Immunodeficiency Virus (FIV) is a lentivirus in the family Retroviridae producing chronic disease in domestic and many non-domestic cats. The disease process is similar in both domestic and non-domestic cats. FIV has been diagnosed in tigers, lions, jaguar, leopards, Florida panthers, and bobcats. FIV causes an immunodeficiency syndrome in domestic cats. In non-domestic felids there is no clear correlation between virus infection and disease. Diagnostic procedures for feline retroviruses include serologic and molecular tests, viral isolation and characterization. Commercial immunoenzymatic tests are considered good initial screening tests. Seropositive animals should be housed separately from uninfected animals.

Several types of experimental vaccines have been tested in domestic cats, but are not commercially available.

Canine distemper, caused by a morbillivirus, has been described in both captive and wild cats. In 1992 canine distemper (CD) outbreaks occurred in Panthera species in three facilities. Two tigers developed neurologic problems (one died and one recovered) at one facility in Los Angeles, while 17 cats of different species contracted the disease and died at another facility in Los Angeles. These included 5 tigers, 4 leopards, 7 lions and a jaguar. Two leopards in Illinois died of the disease that year. The clinical signs generally are enteric, respiratory and CNS abnormalities. The outbreak in Los Angeles spread to captive collections from infected wildlife such as raccoons, and in one case dogs were the source. In 1994 a CD outbreak occurred in lions in Africa with similar CNS signs (depression, anorexia, ataxia, and seizures) and a significant mortality reported.

A canarypox vectored recombinant canine distemper vaccine has been used in some zoo felids. While the vaccine caused no adverse reactions, and the cats did develop significant antibody titers, none of the animals were challenged with the virus so no claims may be made that the antibodies are effective in preventing the disease.

PARASITIC DISEASE

Internal Parasites

Big cats are susceptible to all of the common parasites that are seen in domestic felids. Roundworms, tapeworms, and hookworms may be detected by observation of the parasites in the feces, or by doing a fecal floatation to detect the eggs. Ideally, a fecal floatation should be done on every animal every six months, and on all males and females prior to breeding. Hookworms pose the greatest threat, especially to young animals. Roundworms are the most persistent parasite, and are often the most difficult to eliminate. Prevention is possible if a good quarantine program of new animals is in place, and with good sanitation protocols for all of the animals. Dosages vary and are listed here from different published sources, but should always be approved by the attending veterinarian. Treatments should always be prescribed by the attending veterinarian, and include:

pyrantel pamoate -15 mg/kg/day orally for 3 consecutive days; or 3-5 mg/kg SID orally. Can be given at this level for 3-5 consecutive days

fenbendazole -10 mg/kg orally

mebendazole -10 mg/kg orally SID for 3 days

ivermectin - 0.1 - 0.5 mg/kg orally every 10 days for 4 treatments

febantel (most effective for ascarids)- 10 mg/kg daily for 3 days, repeated at 14 day intervals for 3 treatments; or 6 mg/kg once a day for three days per os..retreat in two weeks.

Levamisole has been used however local reactions have been described and it is not recommended. Organophosphates are STRONGLY DISCOURAGED for treatment of parasites in big cats.

External Parasites

Big cats are susceptible to fleas and their haircoat should be checked regularly in areas where fleas are common. Cougars seem more susceptible to fleas possibly because their skin is thinner than other big cat species. Treatment would be similar to treatments for domestic cats.

Ear mites have been observed in big cats and may be treated with thiabendazole or ivermectin.

OTHER COMMON MEDICAL PROBLEMS AND ISSUES

Gastritis is commonly seen in cheetahs and is usually caused by a Helicobacter bacteria.

Antibiotics and acid-inhibitors are used to resolve the problem.

Cheetahs are also prone to oral lesions and dental problems related to their carnassial teeth growing and penetrating into the hard palate and into the sinus. This may be prevented by filing down the tips of the carnassial teeth in mild cases. In more serious tooth conditions where the carnassial tooth penetrates the hard palate, a root canal may need to be done on the carnassial teeth and the tips filed more aggressively to prevent them from burrowing into the sinus and creating a chronic sinusitis.

Pyloric Stenosis: Numerous tigers have had a pyloric stenosis requiring a Z-Y plasty surgery to repair the problem. These cats all recovered fully and never exhibited the problem again. No etiology could be determined, but several of these cats were closely related. Tigers present with a history of sporadic-to- frequent regurgitation after eating a meal. The problem may be intermittent initially, but will usually progress until it is a daily occurrence. Generally the diagnosis is made from the history, as it is difficult to obtain diagnostic radiographs of the pyloric region due to the average size of a tiger.

Degenerative spinal lesions in big cats: There have been several reported cases of intervertebral disk rupture in tigers, and evidence of degenerative spinal lesions in lions, tigers, and leopards. Some cases of intervertebral disk rupture have resolved with no treatment, while others were resolved with surgery to remove the fragments of disk material from around the spinal cord. These surgical cases require a great deal of aftercare to ensure success. (See References)

Dental problems

Root canals are done routinely in large cats that have broken a tooth. These require a few specialized instruments but are otherwise fairly straightforward to do.

Declawing big cats:

The opinion of many seasoned zoo veterinarians is that declawing big cats, especially the larger species, is inhumane. The problem with most declawing techniques is that P-3 is damaged or removed with the claw. That leaves the cat with P-2 bumping abnormally into the pad for the rest of its life. Usually after about 10 years of age, these cats, the larger of which may reach an adult weight of over 200 kg, will tend to walk back on the posterior portions of their feet, avoiding the pressure of walking normally on their toes. They are prone to pad ulcerations, they tend to gradually develop arthritis in other joints from walking abnormally, have been known to develop back problems, and they almost always seem foot-sore. Cats use their claws for balance and for grasping. They derive a certain amount of enrichment from using their claws. Depriving them of their claws because they have an owner that has no idea of how to handle or manage them seems unjustified.

Reproductive problems

Mammary tumors and endometrial hyperplasia are observed at higher frequency in animals implanted with melengesterol acetate birth control implants.

HAND-REARING

HUSBANDRY OF YOUNG CUBS

Hand-rearing felids is generally straightforward. The most ideal situation for the cubs is to let the dam care for them and raise them. When planning to pull cubs early a few husbandry guidelines should be followed.

- Cubs should be left with the mother for a minimum of two weeks. The only reason to pull the cubs earlier would be a lack of maternal care, or an obvious medical problem with a cub. From a veterinary standpoint, cubs left with the mother for three weeks would be more ideal, as the cubs have an extra week of perfect diet (mother's milk). From a trainer's standpoint, and because of the ease of getting the cub(s) to accept the bottle, two-week old cubs are easier to work with.
- Cubs, once pulled from the mother, must be protected from other cats and pathogens as much as possible (i.e. strict quarantine). They are very susceptible to a variety of cat

diseases before the age of six weeks or before they have received appropriate vaccinations to help to prevent the diseases.

- Cubs should receive vaccinations at four and again at six weeks of age. Once they have received the second vaccination, their immune system is much more able to meet challenges, and it is not necessary to keep the cubs in strict quarantine.
- Cubs will continue to receive vaccinations at 9, 12, and 16 weeks of age to ensure their immune system is challenged when the maternal antibodies have worn off.

Caregivers who plan to take the cubs to their homes in the evenings before they are six weeks of age must meet the following criteria:

- Cubs must not go to a house where a domestic cat lives. Viruses live in the environment for varying amounts of time, and whenever possible, cubs should not be brought into environments where cats have lived within the past six months (ideally in the past year)
- Unvaccinated cubs may ONLY be handled by designated caregivers who have changed from street clothes into clean clothes (scrubs or sweats) and have not been in contact with another cat. Street shoes should never be worn around the cubs until after their 6-week vaccinations. Caregivers will shower in advance of handling the cubs if they have handled or been near other felines during the day.
- For consistency in care, cubs that are younger than four weeks of age should have a limit of four primary caregivers. The fewer, the better. Once the cubs are consistently on the bottle, more caregivers may participate, but must exhibit the ability to exactly follow the handling and care instructions of the primary caregivers. Consistency in early care will help to eliminate health or behavioral problems later on.
- Once the cubs have reached six weeks of age and have received their second vaccination, they will be released from quarantine, but will still be handled with care, and not exposed to domestic house cats.

FEEDING RECOMMENDATIONS FOR CUBS

Tips for formula selection and formulation

Commercial puppy milk replacers such as Esbilac are high in fat, while kitten milk replacers such as KMR are higher in carbohydrates and protein.

Members of *Panthera sp.* (tigers, lions, leopards) do not generally tolerate milk replacers that are high in carbohydrates, and Esbilac is usually the formula of choice. Other formulas that have been used with success in big cat species are listed at the end of this section in the Resources section.

Most *Panthera* species will benefit from the addition of chicken or turkey baby food to the formula at about two weeks of age. This increases the total protein of the formula and tends to prevent loose stools. Taurine is an essential amino acid for felids and taurine deficiency has been reported in hand-reared cubs. *Panthera* species raised on Esbilac should be supplemented with 250 mg of taurine per day.

The smaller species of the genus *Felis* tend to thrive on the kitten milk replacers (KMR). This formula already contains taurine so supplementation is unnecessary.

Powdered milk replacers are much less expensive than the canned formulations. There are important considerations when using the powdered products. A common mistake is making the formula too concentrated. This will result in digestive upsets such as diarrhea or constipation. The formula should be made up exactly the same each day. When using powdered Esbilac or Milk Matrix 33/40, the ratio of powder to water by volume is 1:2. Formula made up to this ratio is called the stock formula. Use bottled water to make the formula, as municipal water often has undesirable additives. Do not over-blend the formula as it can add air to the formula and cause digestive discomfort. Heating the formula to the correct temperature for each individual cub is important. Some cubs are not particular, and will drink the formula at most any temperature. Some cubs are very fussy and will only accept the formula if it is warm enough. Care must be given not to overheat the formula as it may cause the proteins to denature. If the formula is heated in a microwave, test it on your wrist to ensure it is well-mixed after heating because there will be pockets of formula in the bottle that are too hot to feed safely.

When commercial diets are not available there are home made formulas which may be suitable. Lion cubs have been successfully raised on the following formula:

Whole cow's	160
milk	ml
Cream	10 ml
1 egg yolk	20 ml
Gelatin powder	30 ml
Sunflower oil	30 ml

Cougar cubs have been raised using this formula:

Whole cow's	168
milk	ml
Cream	10 ml
1 egg yolk	20 ml
Gelatin powder	25 ml
Glucose	2 ml
Powder	30 ml
Sunflower oil	

Feeding guidelines

Newborns should be started on a dilute formula initially using 25% stock formula : 75% water. The strength of the formula may be gradually increased to full strength over the next 24 to 36 hours. Dehydrated cubs should be given subcutaneous fluids until they are sufficiently rehydrated.

Large felid species may consume approximately 12 to 15% of their body weight per day. This is generally divided into feeds every 3 -4 hours (6 feeds per day) initially, but in the first week if the cub is nursing well and gaining weight, the feeding frequency may be dropped to five and

then one to two weeks later, four times per day. The large felid species should gain approximately 100 to 200 grams of body weight per day. Cubs should be weighed daily and the amount of formula to be fed that day may be calculated based on their daily body weight.

Cubs may be weaned off the bottle gradually once their canines have erupted; usually at 4.5 to 5.5 weeks of age. Canned ZuPreem or other nutritionally balanced carnivore diets are introduced to the diet and are initially mixed in with the formula. Meat in the form of the adult diet, may be introduced into the diet gradually. One method is to utilize the canned ZuPreem initially, and as the cubs become accustomed to eating that diet, the adult meat diet is gradually introduced. Cubs should be consuming a primarily meat diet by the time they are 12 weeks old. Bottles of formula may still be offered but should not constitute the bulk of their dietary intake.

Common Problems Reported in Hand-Reared cubs

Metabolic bone disease is a result of feeding a diet with an inappropriate calcium: phosphorus ratio. The calcium should be approximately 1.7 times the phosphorus in the diet. Organ and muscle meat are very high in phosphorus and calcium must be supplemented in appropriate amounts to prevent this problem. Thin bone cortices as well as hairline fractures and intermittent lameness are all signs of metabolic bone disease. Radiographs will confirm the poor bone density.

Diarrhea is common, and usually due to problems with the formula. It could be an inappropriate formula for that species, or the way in which the formula has been prepared (often powdered formula made up too rich). It could be due to the lack of thoroughly cleaning utensils and bottles after each feeding, or overfeeding the cubs. Diarrhea could indicate an underlying illness as well, and cultures should be submitted to rule out infectious disease such as salmonellosis.

Caregivers should avoid contact with other animals, especially cats, during the hand-rearing process. Separate clothing should be worn when handling unvaccinated cubs. Cubs should be quarantined from all other animals, being handled only by their immediate caregivers until after receiving their second vaccination. Cubs may receive their first vaccination at 4 weeks of age and again at 6 weeks old. Unvaccinated cubs are extremely susceptible to feline panleukopenia as well as other feline diseases.

Resources

Source of taurine: Dyna-Taurine, Harlmen Corp. (800) 393-0794 e-mail: info@harlmen.com

Esbilac, Milk Matrix 33/40, KMR: PetAg Inc, 261 Keyes Ave, Hampshire, IL 60140 (800) 323 6878 www.petag.com

Nutrall: Veterinary Products Labs (888)-241-9545

Just Born: Farnum Pet Products (800)-234-2269

ZuPreem Feline Diet: Premium Nutritional Products, Inc., P.O. box 2094 Shawnee Mission, KS 66202 (913) 438 8900 www.zupreem.com

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