Since surgical complication rates increase with surgical time, factors that reduce complications include training, experience, treatment planning, and instrumentation. However, a practice owner must consider both business and procedural factors when purchasing equipment. With a solid background in general surgery, the training, equipment, and instrumentation expenses that are required to elevate dental practice to a very profitable service are minimal and has a rapid return on investment. Over 70% of dogs having dental disease, and veterinary economists have recognized veterinary dentistry as a major service opportunity.

Selection of instrumentation is largely a matter of personal preference, and the instruments presented in this lecture are a survey of instruments commonly used by veterinary dentists. As with any equipment purchase, quality instruments will last and stay sharper longer than those made of cheaper alloys. Very few instruments in small animal dentistry are specifically designed for veterinary patients. While a few vendors have currently cornered the veterinary dental market, human dental vendors may have superior equipment at lower prices. Before buying instruments and equipment, get recommendations from veterinary and human dentists.

Dentistry is frustrating for veterinarians who are improperly trained and equipped. Having the right instrumentation and dental operatory equipment facilitates efficient and effective Oral Surgery and makes dental practice enjoyable.

The Dental Operatory

Most dental procedures are nonsterile, and professional dental cleanings with a ultrasonic scaler results in the aerosolization of oral bacteria and debris; therefore, dentistry should not be performed in the sterile surgical suite, but rather in a low traffic area, preferably a dedicated dental suite, to minimize the spread of oral pathogens. Since anesthesia is required to perform a professional dental examination on small animal patients, the dental suite should have appropriate ventilation and an anesthetic scavenging system. Most dental procedures produce a wet field; therefore, the operating table should be well drained. Since anesthetized patients with wet heads are predisposed to hypothermia, dental tables with solid, heated surfaces may be preferred over grated wet tables. Lowheat, high-intensity operatory lighting may be adequate for cursory examinations and treatments; however, thorough oral examination and treatments require targeted lighting and magnification from a headlamp and loupe lighting systems. An adjustable chair facilitates operating from an ergonomic neutral body position which reduces work fatigue. Operator fatigue precipitates impatience, frustration, poor surgical technique, and complications.

Personal Protection Equipment

As previously mentioned, in addition to the spread of operatory tissues, pathogens, and material through physical contact, ultrasonic scaling aerosolizes oral debris. Veterinary dentists should ensure that staff members are properly dressed for the specific procedure being performed and for the individual patient being treated. Protective garments/equipment include gloves, surgical face masks, caps, face shields, safety glasses, disposable lab gowns, washable smocks, and ear plugs.
Anesthesia Equipment

Professional oral examination and treatment of small animal patients requires General Anesthesia, which is beyond the scope of this presentation. Specific anesthesia concerns related to dental procedures will be described in the next presentation.

Examination Instrumentation

The minimum instrumentation required for professional oral examination in small animal patients includes bright, targeted lighting, a dental explorer and a periodontal probe. Surgical head lamps with magnification (Loupes) are the gold standard of operative lighting; however, outdoor headlamps and safety glasses with magnification will improve visualization within the mouth. Dental explorers are used to tactilely identify defects in the teeth. An explorer will slide across healthy dental tissue and drag or penetrate into diseased tissue. The #23 shepherd’s hook/sickle is the most common explorer; however, the #17 facilitates exploration of the distal aspect of teeth, and the #11/12 is designed to explore the subgingival cementoenamel junction and furcation of teeth. Dental explorers are sharp instruments which must be maintained.

Periodontal probes are designed to measure the depth of periodontal pockets, but can also be used for other measuring applications, e.g. measuring the size of an oral mass or measuring the dimensions of a mucoperiosteal flap. Walking the probe within the gingival sulcus is proper instrument technique, because dragging the probe along the bottom of the sulcus can damage the periodontal attachment. Probes with Williams markings (1,2,3,5,7,8,9,10mm) are ordinarily used in veterinary general practice, while many veterinary dentists prefer UNC 15 markings (1,2,3,4,5,6,7,8,9,10,11,12,13,14,15mm) for surgical applications. The Nabors probe has a curved working end and is specifically designed to measure furcation exposures.

Although not required in dogs and cats, the use of a speculum, cheek retractors, and mouth gags facilitates examination of large animals and pocket pets. These instruments should always be used with caution in any species, and the use of spring-loaded mouth gags should be avoided. Hyperextension of the jaw secondary to the use of spring-loaded mouth gags has caused permanent blindness in cats. A better option for holding the mouth open is to cut syringe casings or intubation tubing to size for each patient.

Dental Radiography Equipment

Dental radiography equipment provides superior image quality compared to standard veterinary radiography equipment, can be used table-side in the dental operatory, and has a rapid return on investment. Digital dental radiography systems are the standard in veterinary practices. These systems are less technique sensitive than traditional wet films and have technique adjustment and magnification features. Digital Radiography (DR) can produce images on the computer monitor within a few seconds of exposure, but the sensors only come in dental film sizes one and two. This small film size often necessitates taking multiple radiographs to completely evaluate the strategic teeth (canines and carnassials) in large breed dogs. In Computed Radiography (CR) systems, production of an image typically take between 30-60 seconds, but the phosphor plates used in these systems come in dental film sizes up to size four, and larger custom sizes, which means that fewer films are required to produce a full mouth study.

Dental x-ray generators typically have fixed kVp (60-70) and amperage; therefore, exposure time is varied to adjust the imaging technique. Dental generators (typically 8 amp) can be mounted to the operatory wall or to a mobile stand. In addition to wearing radiography gowns
and dosimeter badges, staff members should stand at least six feet from the x-ray generator during exposure and should not stand directly in front of or behind the tube. Hand-held dental x-ray generators are also available; however, the amperage on these units is limited to 2 amps; therefore, longer exposure times, up to 2 seconds, may be required to image teeth on large patients.

**Oral Surgery Pack**
- Scalpel handle and blades
- Periosteal elevator
- Tissue forceps
- Scissors, fine tissue
- Soft tissue retractor
- High-speed handpiece
- Bur block: carbide burs & diamond burs.
- Winged elevator set and/or luxator set
- Root tip elevator or pick set
- Extraction forceps, small breed
- Root tip forceps
- Bone curette
- Surgical gauze
- Needle holders
- Suture material

The instruments indicated in **Bold** type in the descriptions below are the author’s preferences.

**Scalpel Handle and Blade**
The standard Bard-Parker **size 3** handle is the most popular used handle in veterinary surgery. The **size 7** handle is a long, writing pen style handle that is preferred by some dentists because the length allows for better visualization. The preferred scalpel blades in oral surgery are **#11** and **#15**. The #15 blade is similar in shape to a #10, but is smaller and is the most commonly used blade in oral surgery. The #11 blade is triangular in shape, and the point facilitates delicate sulcular incisions in small patients and in restricted spaces such as the gingival tissues of incisors. Intentional bone contact with the blade occurs during oral surgery, and frequent blade changes are required.

**Periodontal Elevators**
Periodontal elevators are sharp instruments used to elevate and retract soft tissues during oral flap surgeries. Freer and Molt #9 elevators are used to elevate large flaps. The **Molt #2/4** has small rounded blades and is sized for oral surgery. The tiny blades of the **EX9C (Cislak Manufacturing)** facilitate elevation of flaps in cat sized patients.

**Tissue Forceps**
Delicate tissue forceps such as Brown-Adson with 7x7 or 1x2 teeth are used in oral surgery.
Scissors

Delicate tissue scissors with sharp blades are required to accurately cut and trim oral tissues. Most dentists prefer instrument lengths of 4.5” to 6,” and both straight and curved blades should be considered. Scissor designs include Goldman Fox #15, Iris, La Grange, Metzenbaum, and Steven’s Tenotomy scissors. These scissors all have two sharp blades, and scissors with one serrated blade facilitate holding the tissue while cutting. La Grange scissors have an S-shaped, double-curved blade and handle and facilitate cutting deep tissues under mucosal flaps.

Soft Tissue retractors.

Tissue retractors are used to improve visualization of the oral field and to retract mucosal flaps. Desmarres eyelid retractors effectively isolate the lips to expose the vestibule. Senn and 5mm Joseph Double Hook retractors can be used to retract mucosal flaps during periodontal surgeries and extractions. R9 and Shanallec RT-4 retractors (Cislak Manufacturing) are small retractors designed to retract flaps in restricted areas.

High-Speed Handpieces

Air driven, high-speed handpieces are low torque engines (they stall when the bur binds) that rotate between 200,000 to 400,000 rpm, and are designed for cutting teeth and bone. Water cools and lubricates the bur and tooth during drilling. Modern wrenchless handpieces have latched or push-button chucking mechanisms to facilitate rapid bur changes. Many handpieces are now available with internal LED light systems which deliver light directly to the cutting area. Some are available with a quick release coupler attached to the air hose that facilitates handpiece removal for maintenance and sterilization. Some feature fully rotating swivel connectors that reduce “tubing torque” and significantly reduce hand and wrist fatigue which over time causes occupational injuries such as carpel tunnel syndrome. Handpiece head sizes vary, from small heads that improve accessibility in the caudal mouth and improve visualization in small patients to large heads that house larger turbines/chuck assemblies that provide the increased power necessary for driving the surgical length burs that are routinely used in veterinary oral surgery.

Investing in a handpiece can be a significant capital investment, but the long-term operational maintenance costs must also be considered. A handpiece can be broken down into two major components: the body and the turbine/chuck assembly. Body failure is unusual but is primarily caused by corrosion due to sterilization. The most common material used in handpiece manufacturing is brass followed by stainless steel and recently titanium. The corrosion resistance and the price increase with each material respectively.

The only moving part in the handpiece is the turbine; therefore, the majority of handpiece failures occur in the turbine/chuck assembly. When purchasing a handpiece, the cost, warranty, expected life, and ease of repair/replace of the turbine/chuck assembly, as well as the down time created by the failure, should be considered. Signs of failure include bur wobble or stall, unusual handpiece vibration or noise, and bur retention failure.

Handpiece life can be prolonged through proper use and maintenance. Air pressure and quality significantly affect turbine life. Most handpieces are designed to operate at 30-40 psi. Excessive air pressure and oil & water condensation from the air compressor (discussed below) cause excessive wear on the turbine. Also, the use of poor quality, dull, and surgical length burs increases lateral forces on both the turbine and chuck causing premature failure. Finally, the high volume of periodontal surgery and exodontia in veterinary practice shortens the achievable
lifespan of dental handpieces when compared to human dental practices. Handpiece maintenance should be performed after each patient or after every 2 hours of use during extend procedures. General handpiece maintenance includes the following steps:

1. Never run a handpiece without a bur inserted into the chuck.
2. Prior to removing the handpiece from the air line, flush water through the handpiece for 30 seconds to remove contaminants. (CDC Guidelines)
3. Surface clean the handpiece with a brush under running water, holding the handpiece upright. Do not use chemical solvents.
4. Dry the handpiece to minimize corrosion.
5. Lubricate the handpiece according to the handpiece and lubricant instructions. Only use the lubricant recommended by the manufacturer during the warranty period of the handpiece and/or replacement turbines. Only apply lubricant into the drive air line hole (the smaller of the two large holes). Install a bur (not a bur blank), and run the handpiece for 20 seconds to ensure the lubricant is evenly distributed into the turbine and that excess lubricant is expelled, then remove the bur from the handpiece before sterilization.
6. Clean fiberoptic surfaces with alcohol on a Q-tip.
7. Sterile pack the handpiece. (CDC Guidelines)
8. Autoclave the handpiece, ensuring the drying cycle is complete. (FDA mandated) Lever-style handpiece chucks should be closed during sterilization.

**Air Compressors and Dental Delivery Systems**

Air-driven dental handpieces can be powered by either air compressors or bottled gas. Bottled CO₂ and nitrogen are used by some mobile dentists, but are usually more expensive to maintain than an air compressor. Oxygen should not be used to power air-driven equipment, because a spark could cause an explosion. Air compressors can be placed table-side (usually attached to the dental delivery system) or remotely (usually placed in a utility area). The primary considerations for the selection of the compressor placement are the space in the dental operatory, the number of delivery systems being powered, the noise produced by the compressor, and the present and future dental caseload. In mobile or small dental practices, a dental delivery system with a self-contained “silent” compressor is conveniently maintained and rolled out of the area when not in use. In larger dental practices, a remote air compressor can power multiple dental stations less expensively while providing less noise and easier maintenance.

Dental delivery systems (platforms, stations) deliver air and water to the handpieces and have second-stage regulators to control the flow/pressures of each. The station should have a three-way syringe (air, water, air/water spray) and a minimum of two handpiece lines. Each line should provide both air and water, with individual controls to regulate the flow/pressure to each handpiece separately (not all veterinary models do). Automatic on/off switches for the handpieces and water save time.
Dental Burs

Dental burs are expendables which should be replaced frequently. Dull burs cut inefficiently and are a major cause of handpiece failure! There are three categories of dental burs: HP (Handpiece), RA (Right Angle, latch type), and FG (Friction Grip). HP and RA burs are designed for use in low-speed handpieces and have a larger shaft diameter (2.35mm) than FG burs (1.6mm shaft diameter) which are used in high-speed handpieces. Burs are named by the shape of the working head (e.g. round, cylindrical, taper) and by ISO numbers.

**Carbide FG burs** are manufactured in 3 shank lengths: Short (16mm), Standard (19mm), and Surgical (25mm). The head of the FG burs are also manufactured in 3 lengths: S (short), L (long), and standard (no letter designator). Standard cutting heads have 6 to 8 flutes while finishing heads (Goldies) typically have 12 flutes. “Cross-cuts” are horizontal notches in a fissure bur’s flutes designed to remove hard tissue more aggressively than plain flutes. **Round burs** are all purpose burs and come in sizes 1/4, 1/2, 1, 2, 3, 4, 6, and 8. **Cylindrical burs** (sizes 556, 557, and 558) have parallel walls and are primarily used in cavity wall preparation. **Tapered-fissure burs** are designed to section teeth with plain flute sizes 168-173 and cross-cut sizes 699-703. (557L, 699L, 701L, 701LS)

**Diamond FG Burs** cut by grind, are primarily used as finishing burs, but are also used for gingivoplasty and alveoloplasty. Diamond burs are manufactured in confusingly numerous shapes and sizes with less standardization than carbide FG Burs. Bur head sizes are usually listed in millimeters, and several grit sizes are available: ultra fine (white), extra fine (yellow), fine (red), medium (blue), and coarse (green), extra course (black). **Course burs** (green) are appropriate for almost all veterinary applications. Diamond bur cleaning blocks extend the life of burs by removing hard tissue from the bur.

**Bur blocks** are used to organize, store, and autoclave dental burs.

Dental Elevators & Luxators

**Dental elevators** are used to stretch/fatigue the periodontal ligament during exodontia. Elevators are inserted into the periodontal ligament (PDL) space, and force is applied to the tooth by axial rotation (torque) of the instrument. Veterinary elevators are typically sold in sets of 4 with head sizes of 1, 2, 3, and 4mm. Larger elevators 6 and 8mm are also available. **Winged elevators** with wider blades provide more circumferential root contact and are popular in veterinary dentistry.

**Dental Luxators** have a sharp slim tip designed to wedge into the PDL space and expand the alveolar bone while cutting the PDL as the instrument head is forced apically. The head is inserted multiple times circumferentially around the root until the tooth is luxated. Twisting a luxator, as an elevator to pry a tooth, will damage the fine instrument head.

**Apical luxators/elevators or root tip picks** (ED10, Heidbrink) are fine instruments deigned to luxate/elevated fractured root tips. They are also effective during exodontia of tiny cat teeth. (Cislak luxators 1.3S, 2S IC, 2S OC, 3S)

Dental luxators and elevators are available in various head and shaft shapes & sizes to fit different teeth, and in various handle shapes & sizes to fit different operators. Large handles usually provide more control. All dental luxators and elevators are sharp instruments that require routine maintenance. They should be used with care since excessive or inappropriate force, often associated with dull instruments, can break the tooth, alveolar bone, and/or jaw. If the elevator looses purchase and slips, penetration/damage of peripheral tissues can be catastrophic (e.g. palatine artery laceration, oronasal fistula, mandibular canal penetration, and eye injuries).
Penetrating injuries are prevented by holding the elevator with a short finger-stop grip. The handle of the instrument is held within the closed hand with the index finger extended to the head of the elevator.

**Dental Forceps**  
*Extraction Forceps* are used to remove the tooth from the alveolus during exodontia. They come in a variety of designs and sizes, and forceps designed for veterinary patients typically provide better purchase on carnivore teeth than human forceps. The elevated tooth is extracted with a gentle twisting and pulling action of the forceps. Since significant mechanical advantage is achieved with larger forceps, the author recommends using only small forceps and finger pressure to prevent iatrogenic tooth fracture.

*Root Tip Forceps* (Peet’s Forceps, Fragment Forceps) have fine, pointed, serrated or diamond-coated tips at a 45-degree angle to the handle. They are designed to reach into the alveolus to grasp loosened root pieces.

**Bone Curettes**  
Bone Curettes are used to debride the alveolus of necrotic and granulation tissue after tooth extraction. Two styles of bone curettes work well for this purpose: spoon-like working ends (Miller & Lucas Curettes) and scoop curettes (*House ear curette*). Small sized (2 to 3 mm) double-ended instruments are typically used for small animal veterinary patients.

**Surgical Gauze**  
2x2in and 4x4in surgical gauze is used depending on patient size.

**Needle holders**  
The needle holder design and size are a surgeon’s preference; however, the head should accommodate a small, delicate needle, and the length should be long enough to ensure visibility by keeping the operator’s fingers out of the mouth. 5.5” length is popular with many veterinary dentists. *(Mayo Hegar, Olsen-Hegar)*

**Suture Material**  
By definition the oral cavity is a clean, contaminated environment; therefore, a monofilament material is preferable over a wicking braided material. A material with good knot memory allows for small knots which reduces suture contamination by food. Oral mucosa and gingiva are vascular tissues that heal more rapidly than skin; therefore, a rapidly absorbable material reduces or eliminates the need for suture removal. Since the gingiva and palatal mucosa are keratinized tissues a swaged-on reverse-cutting needle *(P-3)* is recommended for oral surgery; however, a taper *(RB-1)* needle is sometimes preferred for delicate periodontal procedures.

Currently, the preferred suture of most veterinary dentists is poliglecaprone 25 *(Monocryl)* in sizes 4-0 and 5-0, with a swaged-on reverse-cutting *(P-3)* or taper *(RB-1)* needle. Vicryl *Rapide* and Chromic Gut are used by other veterinary dentists, but most consider the use of polydioxanone (PDS) contraindicated due to it prolonged resorption time.
Other Surgical Materials

Hemostatic Agents and Bone Grafting Materials are heavily marketed and often discussed during tooth extraction presentations. They are described in another presentation, but are rarely used by the author during exodontia.

Instrument Maintenance

Dental instruments and materials should be color coded and organized onto instrument trays by dental discipline or procedure. Such organization has been shown in ergonomic studies to reduce surgical time. The author has an examination tray, surgical tray, restoration tray, vital pulpotomy tray, etc. Following use, instruments should be hand and ultrasonically cleaned, before being sharpened, autoclaved and repacked for the next use.

Almost all dental instruments are sharp tools that rapidly dull due to hard tissue contact. Dull instruments precipitate impatience, frustration, poor surgical technique, and complications. Synthetic and natural stones in flat and conical shapes are used to hand sharpen instruments. Hand sharpening techniques are described in Hu Friedy’s Instrument Sharpening Manual which is available online. Hu Friedy also has instructional videos on YouTube which demonstrates hand sharpening techniques. Practices that have a heavy dental or surgical caseload should consider purchasing a sharpening machine.

Electrosurgery, Radiosurgery, Laser Surgery

These modalities are beyond the scope of this lecture. While these modalities in experienced hands are beneficial in select oral surgery cases, they can also cause severe complications. Thermal bone necrosis secondary to gingivectomy occurs too frequently.
Numerous complications from extraction procedures have been reported. Soft tissue complications include iatrogenic laceration of the oral soft tissues and hemorrhage/hematoma from laceration of the infraorbital, lingual, and palatine vasculature. The extraction of a tooth can cause soft tissue trauma to the adjacent (lip, cheek) or apposing soft tissues (palate) which requires odontoplastic or orthodontic correction. Fractured retained root fragments can become infected causing osteitis and draining tracts. Hard tissue complications include oronasal fistula and fracture/sequestration of the alveolar, mandible, and facial bones. Instrument slippage has resulted in puncture of the mandibular canal, nasal passages, and the orbit & periocular tissues. Secondary regional infections and endocarditis have also been reported as complications of exodontia.

Inappropriate scheduling precipitates impatience, frustration, and rushed procedures which are often results in complication in veterinary dentistry. A comprehensive preoperative assessment and treatment planning facilitate accurate procedural estimates and scheduling, reduce time under anesthesia, and prevent unexpected complications.

Staffing, Scheduling, and Fees

The minimum recommended dedicated staff for a dental case is a veterinarian and two technicians/assistants. The veterinarian is responsible for case management and performing surgery. The technician is responsible for monitoring anesthesia, and the assistant manages the instrumentation and materials and assists with surgery. Ergonomic studies show that a full-time dental assistant reduces operating time by 20%. AAHA, AVMA, and AVDC have published guidelines on the ethical duties and responsibilities of different veterinary healthcare providers, and Tennessee state laws and regulations specifically restrict Diagnosing, Prescribing, and Surgery to licensed veterinarians. Legally and ethically only a licensed veterinarian should extract teeth.

“How long does it take to extract X tooth?” is a frequently asked question by veterinarians entering dental practice. Most veterinarians significantly underestimate the time required to extract teeth. Realities that are counterintuitive include extractions in small dogs can take longer than in large dogs, due to the restricted oral space. Spaced out individual teeth can take longer to extract than a series of teeth, because a single large flap improves access to all teeth and requires only one closure. Extractions can take longer in old dogs, compared to young dogs, due to ankylosis and narrowing of the periodontal ligament (PDL) space.

In preparation for this question, the author searched the VIN Dental Board for responses. Two responses included: a deciduous canine tooth can take 5 to 30 minutes to extract, and a maxillary carnassial tooth often takes new practitioners 60 to 75 minutes to extract, but this time will soon be cut in half as the oral surgery caseload increases. As with any surgery, an accurate time and fee estimate can only be established after a comprehensive oral evaluation. The overwhelming consensus from the VIN consultants was clearly stated by Dr. Jan Bellows, “It takes as long as it takes to do it well!”

“How much do you charge for an extraction?” is another frequently asked question by veterinarians entering dental practice. In the veterinary profession, fees for dental service are greatly undervalued due to a negative bias within the profession that was recognized over a century age, “When dentistry in animals is more generally recognized as an important if not
essential feature of animal therapeutics, and when dental operations by reasons of greater skill are made easier, veterinarians will then treat the art of dentistry with the same dignity as other branches of surgery.” (Merillat, 1906) Professionals sell their time! However, most veterinarians will present an owner with an estimate for an orthopedic surgery (e.g. ACL repair) that exceeds $1000, but will hesitate to present an estimate at the same price for extractions (oral surgery), even though the dental procedure requires the same time and skill level. In order to change this bias and receive fair compensation, veterinary dentists must educate other veterinarians and animal owners about the healthcare value of properly performed dentistry.

Fees in successful practices are based upon the time and materials required to perform a procedure. The price point for a service is also adjusted by the professional’s level of training and experience and by the demographics of the clientele. Oral surgery/exodontia often involves bone manipulation; therefore, pricing similar to orthopedic surgery seems reasonable as a baseline price point. Surgical extraction requires additional training and specific instrumentation; therefore, a higher fee is fair. Advanced dental procedures require extensive training and specialized instruments and materials; therefore, a premium fee is equitable.

Since an accurate treatment plan and fee estimation can only be formulated after the oral evaluation under anesthesia, scheduling is a common frustration for the veterinary staff, and fee estimates are often a source of frustration to both veterinarians and clients. Oral surgery for established disease can be scheduled in one of three ways: 1) immediately following the initial oral assessment and cleaning (COHAT, Comprehensive Oral Assessment and Treatment), 2) Staged or 3) a combination of both. The optimal scheduling method will vary by practice. The author has experimented with all three scheduling strategies and believes the combination approach to be least stressful on all parties.

The “Golden Period” to minimize both anesthetic and surgical complications is generally accepted to be 2 hours. Since the average time to complete a COHAT by a trained veterinary staff is 1.5 hours, the author adds/estimates 1 hour of advanced procedures time during the initial appointment, which is typically allocated for the nonsurgical extraction of mobile teeth and periodontal treatment (closed root planning). The remainder of treatment required to establish a “disease and pain free mouth” is scheduled in subsequent two hour procedures. The benefits of staged oral surgery include shorter anesthetic episodes, a clean surgical field with healthy soft tissue, accurate treatment planning and fee estimation, more time to educate the client, a predictable dental schedule, and a happy staff.

Treatment Planning Considerations

Anatomy

Prerequisite to any surgical procedure is a basic understanding of anatomy. A review of dental and oral anatomy can be found in textbooks and online. An understanding of root morphology facilitates treatment planning for tooth extractions. In dogs the single rooted teeth are the incisors, canines, 1st premolars, and mandibular 3rd molar. Incisors have long thin curved roots, with a mesiodistally flatten oval cross-section. Care must be taken during nonsurgical extraction to prevent root fracture and damage to the adjacent teeth and bone. The maxillary 3rd incisor’s root is robust and is best treated like a canine tooth. Canine teeth have very large curved roots that typically extend dorsally over the roots of the 1st and 2nd premolars. Surgical extraction of canine teeth is almost always required to prevent significant complications. The roots of 1st premolars and mandibular 3rd molar are short and conical which lends to nonsurgical
extraction. The mandibular 1st and 2nd molars and all premolars, except for the 1st and maxillary 4th premolars, have two roots. The maxillary 4th premolar and molars have three roots. Surgical extraction is recommended for all multirooted teeth. The root morphology of the domestic cat is similar to a dog, except cats only have one molar in each quadrant, and the maxillary 1st molar is single rooted. Also, the tooth in the maxillary 1st premolar position is single rooted, but is called the 2nd premolar to conform to anatomical convention.

**Anesthesia/Analgesia**

Professional oral examination and treatment of small animal patients requires General Anesthesia. Specific anesthesia concerns related to dental procedures will be described. Each patient’s Anesthesia/Analgesia Plan should be individualized based upon a preanesthetic evaluation consisting of a clinical and diagnostic evaluation. The veterinary profession has adopted the ASA Physical Status Classification System to guide anesthetic treatment planning:

ASA 1: Healthy Patient
ASA 2: Mild Systemic Disease (e.g. Periodontitis, Regulated Heart DZ or Diabetes.)
ASA 3: Severe Systemic Disease (e.g. Clinical Heart/Respiratory Disease, Diabetes)
ASA 4: Life Threatening Disease (e.g. Pyometra, Sepsis, Uncontrolled Hemorrhage)
ASA 5: Moribund: Less than 24 hours life expectancy.

Since periodontitis classifies a patient into ASA 2, most dental patients are at increased risk of anesthetic complications from poorly planned and executed anesthesia. However, dental disease has also been shown to contribute to these systemic conditions; therefore, ASA 2 and 3 dental patients are regularly treated after evaluation of comorbidities.

The ACVAA and the AVDC recommend continuous multimodal monitoring (T, HR, RR, BP, SpO₂, CO₂) by a dedicated trained technician. Recording the monitored values every 5 to 10 minutes on an anesthesia log and evaluating the trends and significant events minimizes the risk of an anesthetic emergency. All staff members should be trained to recognize critical monitoring parameters that dictate evaluation by a veterinarian.

60bpm < HR > 140bpm (dog), 80bpm < HR > 200bpm (cat)
Mean BP < 60mmHg
Systolic BP < 80mmHg
SpO₂ < 90%
35cm H₂O < CO₂ > 45cm H₂O
94° < T > 102°

Most dental procedures produce a wet field which predisposes patients to perianesthetic complications. All patients should be intubated with a cuffed endotracheal tube to maintain an unobstructed airway and prevent aspiration. A pharyngeal gauze minimizes fluid accumulation in the larynx and throat.

Wet conditions also predispose dental patients to hypothermia, which affects multiple organ systems, precipitates anesthetic overdose, and makes the patient less response to emergency treatments. Risk factors for hypothermia include high ASA, small patient size, senior patient, invasiveness of surgery, and surgery duration greater than 2 hours. *Perianesthetic patient care must address thermoregulation!* The author recommends maintaining a body temperature above 96°. Patients should be kept as warm as possible by minimizing the gas flow
rate, covering the feet with socks, and frequently changing towels and diapers around the head. The patient can be heated during the pre- and post-anesthetic period with cage heaters and during the anesthetic period with a circulating water blanket (better for small patients) or forced air tent (better for larger patients). Electric blankets should NOT be used on dental patients. The author has tested several models of IV fluid warmers with no clinically significant results.

Regional and local anesthesia are routinely used during oral surgery for analgesia and to reduce the general anesthetic requirements. The infraorbital, maxillary, inferior alveolar, and mental nerve blocks will desensitize the mouth. Bupivacaine is commonly used because of its longer duration. Dosing should be calculated, especially in small patients and cats, to avoid toxicity.

<table>
<thead>
<tr>
<th>Local Anesthetic</th>
<th>Onset</th>
<th>Duration</th>
<th>Toxic Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lidocaine</td>
<td>2 Min</td>
<td>2 Hrs</td>
<td>@8mg/kg</td>
</tr>
<tr>
<td>Bupivacaine</td>
<td>5 Min</td>
<td>5 Hrs</td>
<td>@2mg/kg</td>
</tr>
</tbody>
</table>

Rule of Thumb (2mg/kg): Small: 0.1cc per site, Medium: 0.2cc, Large: 0.3cc.

As with all surgeries, the multimodal management of pain and inflammation should begin preemptively and should continue postoperatively.

**Antibiotic Therapy**

This topic has been highly debated for the last decade. Dental procedures are known to cause a transient bacteremia which can localize in distant areas of inflammation; however, an immunocompetent patient should be able to clear this infection without clinical consequences. Also, severe oral infection from periodontal disease often extends into the bone and other regions of the head (nasal passages, periorcular tissue); however, immunocompetent patient should be able to clear these infections once the necrotic tissues are debrided.

Current recommendations suggest that antibiotics should NOT be used routinely during dental procedures. The author is trending toward using antibiotics in fewer dental patients, but will typically prescribe perioperative antibiotic to patients with comorbidities and with moderate regional periodontal disease and postoperative antibiotics to patients that have with comorbidities and extensive periodontal disease. All treatments should be individualized!

**Examination**

“Having our patient ready, we must first give the teeth a thorough examination. This should not be hurriedly done, for on it the subsequent work depends.”

Hinebaugh TD. *Veterinary Dental Surgery*. 1889.

The examination is the foundation of ethical, professional veterinary practice. A veterinarian must examine the patient and make a diagnosis before prescribing a treatment. The oral examination has two phases: a conscious examination and an examination under anesthesia. During the conscious exam, the head, occlusion, and gross oral pathology is assessed to estimate the time required to clean (scale & polish) the teeth. An accurate diagnosis of the types and extent of oral diseases is made during the examination under anesthesia when examination instruments, dental explorers and periodontal probes, are used to examine the sensitive oral tissues and radiography is used to evaluate the dental and subgingival hard tissues. Comprehensive Oral Health Assessment and Treatment (COHAT) and dental charting are
described in numerous texts and journals, and online. *Professional dentistry requires a professional examination, and all healthcare professionals document their examination findings and treatments!*

**Dental Radiology**

The top three oral diseases in dogs are 1) Periodontal Disease, 2) Periodontal Disease, 3) Periodontal Disease, and 3+) Tooth Fracture. The top three oral diseases in cats are 1) Periodontal Disease, 2) Tooth Resorption, and 3) Gingivostomatitis. The periodontal tissues include the gingiva, cementum, periodontal ligament (PDL), and bone. Periodontal disease is present in at least 70% of veterinary patients, and only one of the four tissues that comprise the periodontium can be evaluated visually. Gingivostomatitis is usually associated with periodontal disease and/or tooth resorption, and tooth resorption is a disease of the tooth root. Verstraete and Lommer documented that 27% of dogs and 40% cats have pathology under the gum line that can only be diagnosed with dental radiography. And finally, the primary determining factors of whether a tooth should be extracted surgically is root morphology, clinical attachment level (root to bone), and root resorption. *Veterinary dentistry is very frustrating, time consuming, unprofitable, clinically ineffective, and professionally unrewarding without dental radiography.*

Dental radiographs should be taken preoperatively to evaluate the health of the root, PDL, and alveolar bone. Radiology helps determine the diagnosis indicating, the difficulty of, and the treatment plan for an extraction. Ankylosis is a common indication for surgical extraction and can have radiographic signs of a decreased PDL space, root resorption, and/or increased alveolar bone density (sclerosis). The tooth must have an unobstructed extraction pathway; therefore, tooth root morphology is critical for extraction treatment planning. Root dilaceration (sharp curvature) is almost always indication for surgical extraction regardless of periodontal status.

Radiographs underestimate disease since only the mesial and distal aspects of the roots are imaged, and multiple views are recommended for 3 rooted teeth. It is also generally accepted that bone lysis only becomes evident radiographically when more than 40% of the cortical bone has been demineralized; therefore, radiographs significantly underestimate the extent of the bone loss.

In addition to preoperative radiographs for treatment planning, radiographs should be taken intraoperative any time an extraction is not progressing as expected and postoperatively to confirm complete extraction of all tooth fragments.

**Indications for Exodontia**

The primary indication for exodontia in veterinary patients is periodontal disease, and the incidence and severity increases with age in dogs. There is a strong association between the periodontal staging index and treatment success:

- **PD0 (Normal)** > Brush Teeth (Plaque removal). *Prevention!*
- **PD1 (Gingivitis)** > Professional Prophylaxis.
- **PD2 (<25% Bone Loss)** > Periodontal Treatment (Closed Root Planing)
- **PD3 (25-50% BL)** > Periodontal Surgery (Open Root Planing) or **Extraction**.
- **PD4 (>50% BL)** > **Extraction**.
As a general rule, PD4 level teeth are unsavable even with heroic surgical effort and must be extracted to prevent spread of inflammation and infection, both regionally and systemically. In multirooted teeth, furcation lesions are predictive of tooth loss; therefore, teeth with stage 3 furcation lesions should also be extracted. PD3 level teeth can be saved by performing periodontal surgery, *only if the client commits to life-long home dental care and regular professional assessments/treatments*. The take-home message from this association is that patients should receive regular dental examinations so that periodontal disease can be prevented or treated at an early stage.

The second major indication for veterinary exodontia is untreatable dental cavities. Dental cavities are structural defects in a tooth caused by any etiology (e.g. tooth fractures, tooth resorption, caries). Fractured teeth may be found in 27% of dogs and 10% of cats. Complicated crown fractures with pulp exposure are common in dogs (50% of all tooth fractures) and most commonly occur in the canine teeth (35%). Complicated crown fractures are preferably treated endodontically and restored. Acute tooth fractures (< 48 hours) can be treated with vital pulp therapy; otherwise, vital and nonvital pulp exposures are treated by standard root canal therapy. Teeth that cannot be treated should extracted to eliminate pain and apical abscessation.

Tooth resorption (TR) is a painful progressive disease seen in approximately two-thirds of domestic cats and increases in incidence with age. TR progresses regardless of conservative treatments; therefore, upon diagnosis of a single TR lesion, full mouth radiographs are indicated, and crown amputation or surgical extraction is performed on all affected teeth. Crown amputation is *only* indicated in cats (1) *without* gingivostomatitis and (2) on teeth with *radiographic signs of replacement resorption* [Type 2 TR] and (3) *without* radiographically identifiable periodontal & root structure *or* (4) periodontal or periapical disease.

The third indication for exodontia is interceptive orthodontics where either primary or adult teeth may be extracted to improve functional occlusion. Based upon the principle that *two teeth cannot occupy the same tooth position*, persistent primary teeth should be extracted if they are blocking the correct eruption of an adult tooth. Failure to extract persistent primary teeth in a timely manner often predisposes the patient to periodontal disease and malocclusion which requires more expensive corrective procedures as an adult. In the adult patient, “healthy” teeth may be extracted to prevent periodontal disease of strategic teeth. Such extractions are commonly seen in small breed dogs with crowded and/or rotated teeth. Crowded incisor or premolars may be sacrificed to ensure the periodontal health of the canine or carnassial teeth. Finally, extractions may be indicated to prevent traumatic occlusion when an owner declines orthodontic treatment. For example, crown amputation or extraction may be necessary to prevent palatal trauma in a large breed dog with base narrow canine teeth when the owner declines orthodontic appliance treatment. Maxillary incisors may need to be extracted in a dog with an underbite to prevent trauma to the mandibular mucosa.

The final major indication for exodontia is to provide a definitive treatment to relieve pain and to prevent spread of disease when an owner declines reparative dental treatments. In 1906, Merillat stated in *Animal Dentistry and the Diseases of the Mouth*, “The principal objective of dentistry is to *promote the general health by improving mastication and by relieving pain.*” While this goal has not changed during the past century, in many dental cases we now have the ability to achieve this goal by repairing teeth instead of extracting them. In most cases exodontia does not improve mastication; therefore, extraction should be considered a salvage procedure which is only recommended and performed after other tooth-saving procedures have been preferentially considered.
Owners, and some veterinarians, often perceive that exodontia is easier, faster, and less expensive than “advanced” dental procedures. This perception is often incorrect since properly performed extractions are typically tedious and time consuming, even when performed by experienced dentists. Rushed extractions often result in serious complications (e.g. retained roots, bone sequestration, oronasal fistula, jaw fracture, ocular damage), and properly performed extractions can have lifelong sequella. Both veterinarians and owners should have realistic expectations about fee estimations and outcomes to prevent postoperative frustration.

**Contraindications for Exodontia**

The primary contraindication for exodontia is failure to receive permission to perform the procedure. In addition to legal consideration, tooth extraction can be an emotional decision for some owners; therefore, some veterinary dentists will NOT extract a tooth without specific permission and believe that general permission on the inpatient release form is insufficient.

Systemic disease can contraindicate surgical procedures; however, patients with controlled systemic disease (ASA 2 & 3) that have been cleared for anesthesia should be good candidates for oral surgery. Local conditions which contraindicate exodontia are previous radiation therapy, which could cause osteoradionecrosis, and malignancy, which could disseminate cancer cells.
**ORAL SURGERY: Techniques to Win**
Stephen S. Galloway, DVM

*Extractions are awfully simple or simply awful!*

An understanding of dental and oral surgery principles will significantly improve treatment outcomes.

**Veterinary Dentistry Defined**

Dentistry is the veterinary practice that includes the *evaluation, diagnosis, prevention and treatment* of the diseases, disorders and conditions of the oral cavity, maxillofacial area and the adjacent and associated structures as well as the evaluation of the contribution of oral conditions to the overall health of the individual patient. As with all professional healthcare services, a licensed veterinarian must *examine* the patient and make a *diagnosis* before s/he prescribes specific *treatments*. The author considers dentistry provided autonomously by veterinary assistants/technicians, groomers, and anesthesia-free providers to be below the current standard of veterinary healthcare.

Although veterinary dentistry has been practiced, mostly on horses, since the inception of our profession, dentistry has seen a resurgence in veterinary practice during the past 25 years. This resurgence aligns with the AVMA recognition of dentistry as a *unique veterinary specialty* in 1988 with the formation of the American Veterinary Dental College (AVDC). The AVDC divides the practice of veterinary dentistry into 7 dental disciplines:

1. **Endodontics**: Root Canal Therapy.
2. **Oral Medicine**: *Incisional biopsies*, sialography, masticatory muscle EMG.
3. **Oral Surgery**:
   a. **Simple (nonsurgical) Extractions**.
   b. **Surgical Extractions**.
   c. **Mandibular & Maxillary Fracture Repair**.
   d. **Advanced Hard Tissue Surgery**: Palate, sinus, & TMJ surgery, mandibulectomy, maxillectomy.
   e. **Advanced Soft Tissue Surgery**: Tongue, cheeks, lips, & salivary gland surgery.
4. **Periodontics**: PD1-2 (*Nonsurgical*), PD3-4 (*Surgical*).
6. **Prosthodontics**: Crowns and Bridges.
7. **Restorative Dentistry**: Chairside Restorations.

The disciplines emphasized above (bold) represent approximately half of a veterinary dentist’s caseload, and in the author’s opinion can be performed by interested primary practitioners with a minimal investment in training and resources.
**Oral Medicine (Incisional Biopsy of Oral Masses)**

Malignant tumors of the oral cavity represent approximately 6% of all canine tumors and often go unnoticed by owners until advanced. In dogs, the most likely malignancies are Melanoma (30-40%), Squamous Cell Carcinoma (20-30%), and Fibrosarcoma (10-20%). In cats, the most likely malignancies are Squamous Cell Carcinoma (70%) and Fibrosarcoma (30%). Clinical staging of tumors is based upon the WHO TNM System (Tumor, Nodes, Metastases) and should be performed by the surgeon who will perform curative intent surgery. Treatment planning for curative intent surgery (with required clean tissue margins) is based upon the *definitive* histopathologic identification of the tumor.

It is generally recognized that neoplastic and non-neoplastic masses cannot be differentiated based upon clinical presentation or radiographic findings; therefore, definitive diagnosis is based upon histological assessment, and *all* oral mass should be biopsied. Unlike dermatologic biopsies in which the specimens are taken on the edge of the lesion in order to include healthy tissue, *oral biopsies should remain within the lesion* and should not cross the lesion margin into a healthy tissue plane. The incisional biopsy should include tissue from the worst part of the lesion, and multiple samples improve diagnostic accuracy. Mucosal biopsies should be at least 3mm in diameter (4-6mm preferred) and 2mm deep. Many oral surgeons consider the punch biopsy to be the method of choice for oral soft tissue masses.

**Exodontia**

Tooth extraction has been practiced for over 1000 years and remains the most performed “advanced” dental procedure in veterinary patients. For terminally diseased teeth exodontia minimizes the effect of oral disease upon other teeth, regional tissues, and systemic organs. It relieves pain and improves the patient’s quality of life.

**Exodontia Principles**

Whether simple or surgical extraction is elected, the fundamental principles of oral surgery and exodontia promotes successful outcomes and minimizes complications:

1. Preoperative treatment planning is based upon both clinical and radiologic evaluation.
2. The operator must have adequate visualization of the surgical field (tooth to be extracted).
3. Vital structures (AVN) and adjacent tissues/teeth should not be damaged.
4. The tooth being extracted must have an unimpeded extraction pathway.
5. Controlled force must be used to fatigue/tear the PDL (luxation & elevation) before the tooth is extracted from the alveolus.
6. The extracted tooth is visually examined, and the alveolus is radiographed to confirm complete extraction of the tooth.
Mechanical Principles & Tooth Extraction Instruments

Dental extraction instruments use simple machine technology. Renaissance scientists identified the 6 classical simple machines: Lever, Wheel & Axle, Pulley, Inclined Plane, Wedge, and Screw. These simple machines use a single applied force to do work against a single resistance load.

A lever is a machine consisting of a rigid beam pivoted at a fixed hinge or pivot (fulcrum). On the basis of the location of fulcrum, load and effort, the lever is divided into three types.

1. Class 1 lever: The fulcrum is between the resistance and the force.
   E.g. Dental forceps, scissors, dental elevator (if bone is used as fulcrum)
2. Class 2 lever: The resistance is between the fulcrum and the force.
   E.g. Wheelbarrow, bottle opener.
3. Class 3 lever: The force is between the fulcrum and the resistance.
   Also called a speed multiplier.
   E.g. Tissue forceps, mandible.

The wheel & axle consists of a large wheel fixed to a smaller axle so that a rotational force (torque) is transferred from one to the other. Dental elevators use wheel & axle technology.

An inclined plane (ramp) is a flat supporting surface tilted at an angle, with one end higher than the other, used as an aid for raising or lowering a load. A screw is a narrow inclined plane wrapped around a cylinder. A wedge is a moving inclined plane designed to separate 2 objects. Dental luxators use wedge technology.

Application of mechanical advantage with dental instruments should follow the 3Ps: Purchase, Persistence, and Patience. To maximize mechanical advantage, dental instrument selection should be based upon the best contact between the instrument head and the tooth surface. Since root shape and diameter vary greatly between teeth within a dog’s mouth and between different dogs, a selection of luxators and elevators should be available to maximize instrument purchase. The mechanical advantage provided by dental instruments requires the application of slow steady force. The periodontal ligament is designed to withstand heavy, short duration masticatory forces; therefore, fatigue of the PDL is achieved through the application of light, long duration forces. Force is gradually increased as the PDL fails. The operator must use finesse and patience to prevent iatrogenic damage such as alveolar bone and root fractures. Properly performed tooth extractions take time, and frustration precipitates poor operator technique.

Luxation is the process by which the PDL is cut or severed to loosen a tooth from the surrounding alveolar bone. A luxator is wedged into the PDL spaces between the root and alveolar bone, and then apically directed pressure is held for 10-15 seconds. Proper luxation should elicit PDL hemorrhage. The luxator is moved to another aspect of the root and the process continued circumferential around the tooth.

Elevation is the process by which the PDL is fatigued or torn, and alveolar bone is expanded to facilitate removal of the tooth from the alveolus. After luxation, an elevator is placed into the (distal) PDL space, advanced apically until it stops, and then rotated (torqued) and held for 15 seconds to apply leverage. The process is then repeated in the opposite (mesial) PDL space. Elevation is alternated between the mesial and distal PDL spaces until the root is finger loose. Elevation from the buccal and lingual/palatal PDL spaces tends to fracture
alveolar bone, which is often thinner on these aspects of the teeth. Adjacent teeth should NOT be used as a fulcrum. Inability to elevate is an indication for surgical extraction.

**Extraction** forceps are used to remove the “finger loose” tooth from the alveolus. The beaks should grip the root as far apically as possible. The tooth is then extruded with gentle traction as the tooth is rotated axially in a clockwise or counterclockwise direction. **Forceps should not be used in a rocking motion.**

**Simple (Nonsurgical) Extraction**

Simple extraction (closed, uncomplicated, or nonsurgical extraction) is an extraction not requiring a gingival incision (other than within the sulcus) or sectioning of the tooth. Simple extraction is often recommended for small single-rooted teeth and teeth with severe periodontitis. In dogs these teeth include the incisors, 1st premolars, and mandibular 3rd molars; however, the incisors have a 1:3 crown to root ratio which can make simple extraction challenging. Also, the triangular cross-section and curved shape of the maxillary 3rd incisor often necessitates surgical extraction. In cats, the incisors are amenable to simple extraction. The roots of the premolars and molars have variable morphology.

The general technique for simple extraction has been described above. A circumferential sulcular incision is made around the tooth with #15 or #11 blade to incise the gingival attachment. The tooth is then luxated, elevated, and extracted. The alveolus is debrided, flushed, and closed, as described below in **Alveolar Wound Management.**

**Surgical Extraction**

Surgical extraction (open or complicated extraction) is an extraction which requires a gingival flap, bone removal, and/or tooth sectioning. Surgical extractions are reserved for difficult extractions in which the tooth size, pathology, or root morphology seen on preoperative clinical and radiologic evaluation indicates the potential for difficulty and/or complications. Surgical extractions are more involved but are often time saving and less traumatic (faster healing) in properly selected cases. Specific surgical extraction techniques will be described for the Canine Teeth, the Mandibular 1st Molar, and the Maxillary 4th Premolar in the next presentation in preparation for the wetlab. Surgical principles and general techniques are described here.

**Sectioning and (Simple) Extraction of Multirooted Teeth**

Multirooted teeth that have tapering conical roots or are mobile secondary to periodontal disease are often candidates for sectioning and (simple) extraction. When applicable, this procedure is less traumatic than elevating a full-thickness mucoperiosteal flap for surgical extraction. To start the procedure an envelope flap (described below) is elevated to provide access to the tooth furcation for sectioning. A cross-cut carbide bur (557, 701) is used to separate the roots by sectioning between the crown cusps, cutting from the furcation coronally. Then a simple extraction technique is performed on each root. Although adjacent teeth should NOT be used as a fulcrum for dental elevators, an elevator can be placed between sectioned roots with one section of the tooth serving as a fulcrum to lever the other section. Care should be taken when using this technique since aggressive torque often fractures a root. Once one root is extracted, the interradicular (furcation) bone can be removed if necessary to facilitate elevation of the other root(s). The alveolus is debrided, flushed, and closed.
Flap Principles

Mucoperiosteal flaps are used in surgical exodontia to access and remove alveolar bone covering the roots of teeth that cannot be simply extracted. A complete diagnosis (knowing all of the teeth that must be extracted) is critical to flap design since the extension of a flap to include other teeth after vertical releasing incisions have been made could compromise flap closure and healing. Sharp instruments minimize tearing the flap, and scalpel blades should be changed often since most incisions contact bone. Flap design should include the following principles:

1. The flap should not compromise vital structures, e.g. infraorbital A, V, N; mental N.
2. The flap must be large enough to expose the surgical area, without exposing peripheral tissue unnecessarily. Vertical releasing incisions are not always necessary and should not be used indiscriminately. When learning flap techniques, practitioners should/will create large flaps to facilitate visualization and bone exposure. With experience, dentists will minimize flap size.
3. The width of the flap’s base should be equal to or larger than the free margin to ensure adequate blood supply. Adequate blood supply is the most critical factor in tissue healing!
4. Vertical releasing incisions should be made at the line angle of the tooth being extracted or an adjacent tooth, or in an edentulous interdental space ensuring that adjacent teeth have a complete gingival collar when the flap is closed. A Vertical releasing incision should NOT be cut through an interdental gingival papilla. (A Line Angle is a corner where two vertical walls of the tooth meet.)
5. The length of the vertical releasing incision into the mucosa should be at least the length of the root.
6. The edges of the flap should be supported by bone whenever possible to decrease mobility of the incision after closure.
7. The flap should be gently handled and manipulated. Use stay sutures to manipulate flaps that require extensive development.

Three types of flaps are commonly used in surgical extractions: Envelope flap, Triangular mucogingival flap, and the Pedicle mucogingival flap.

Envelope Flap

An envelope flap is a gingival flap that is commonly used during periodontal surgery and exodontia to gain access to the furcation and root. This is the simplest flap, but it also has the poorest access to the alveolar bone. The flap is created by making a circumferential sulcular incision around a tooth with a #15 or #11 blade to incise the gingival attachment. The envelope flap can be extended horizontally to include several teeth by incising the interdental papillae between the teeth. To expose the marginal alveolar bone, a periosteal elevator is inserted into the buccal and lingual aspects of the gingival sulcus and gently advanced apically using a crab-walking motion to elevate the gingiva and mucosa. In preparation for flap closure, diseased sulcular epithelium is debrided/trimmed using a diamond bur (round, egg, barrel) or scissors. The flap is closed by repositioning and placing interrupted suture interdentally.

If a tooth has severe gingivitis/periodontitis, the dentist may elect to perform an internal (reverse) bevel incision (modified Widman flap) to remove the diseased sulcular epithelium.
Instead of inserting the blade into the sulcus to incise the gingival attachment, the diseased portion of free and attached gingiva is incised with the blade directed toward the alveolar bone. The diseased gingiva remains attached to the tooth. To elevate the flap the periosteal elevator is placed into the incision and the healthy gingival margin of the flap is elevated off the marginal bone. If multiple teeth are involved in the flap, the internal bevel incision should follow the scalloping contour of the gingiva. The collar of diseased tissue is removed with a sulcular incision. The flap is closed by repositioning and placing interrupted suture interdentally.

**Triangular Mucoperiosteal Flap**
A triangular mucoperiosteal flap is the most commonly used flap for surgical extractions. It is a three-cornered full thickness (gingiva, mucosa, & periosteum) flap that consists of an envelope flap with a single vertical releasing incision. The vertical release is usually made over the mesiobuccal line angle of the tooth to be extracted and extends the length of the root. The incision is made with firm pressure through the gingiva and continued in an apical and mesially diverging direction through the mucosa and periosteum in a single stroke. The flap is elevated starting at the corner of the releasing incision carefully working distally and apically to ensure the mucosa is not torn.

**Pedicle Mucoperiosteal Flap**
A pedicle mucoperiosteal flap is a four-cornered flap which provides the best exposure for challenging extractions where extensive bone must be removed such as ankylosed teeth and root tip extractions. As the triangular mucoperiosteal flap is an extension of the envelope flap, the pedicle flap is an extension of the triangular flap, where a second vertical releasing incision is made at the distobuccal line angle of the target tooth.

**Flap Closure**
*Tension-free apposition of the wound margins is critical to the primary closure of all soft tissue wounds!*

In preparation for flap closure, the recipient epithelium and flap gingiva are debrided/freshened using a diamond bur (round, egg, barrel) or scissors. If an internal bevel incision was used to release the flap, this step will be unnecessary or minimal. Healthy keratinized gingiva should not be trimmed from the flap margin because it provides better purchase for suture than nonkeratinized mucosa. The recipient edges of the palate are elevated to facilitate placement of the suture needle.

Most flaps will not close over the extraction site without tension if returned to their original position; therefore, they must be coronally repositioned. A full-thickness flap consists of the elastic mucosal layer and the inelastic periosteum. A periosteal releasing incision is performed to provide elasticity to the flap. Sharp scissors are used to bluntly dissect between the periosteum and the mucosa, and then the periosteum is cut at the base of the flap. The flap is positioned and tested to ensure a tension free closure before suturing. If a minor tear of the flap occurs during elevation, usually at the mucogingival junction, the tear can be closed with suture. Major tears may require trimming before closure.

Simple interrupted sutures with bites 2-3mm apart are placed to close the gingiva at the mesial and distal corners of the flap, ensuring a gingival collar wraps around the adjacent teeth. Once the corners of the flap are secured, the remainder of the flap and the mucosal releasing incisions are closed, placing sutures 2 to 3 mm apart. Since the mouth is a high mobility area,
to 6 throws are preferred for knot security. Suture should appose the tissue margins without crushing and should not be expected to provide a hermetic seal for the flap; therefore, lacerated vasculature should be ligated before flap closure. Suture pattern is often opined and debated, but lacks scientific evidence. Much of the veterinary literature anecdotally supports the use of the simple interrupted suture pattern; however, suture line contamination, tissue irritation, and closure time are associated with knot number and size. In the human literature, there is support for using continuous patterns in edentulous areas, and the Ford interlocking pattern is favored by some veterinary dentists. The author places simple interrupted sutures strategically and then closes the flap with a continuous pattern: simple continuous, Ford interlocking pattern or Aberdeen continuous, interrupted.

Alveolectomy & Alveoloplasty

Once a flap has been raised successfully, the buccal alveolar bone covering the root(s) is removed to facilitate tooth elevation. An end-cutting carbide bur (round or pear bur) on a water-cooled high speed handpiece is used to remove the bone by making sweeping “paint brush” strokes across the bone. In maxillary canine and carnassial teeth, the prominent jugae outline the roots and guide bone removal; however, cortical bone masks the roots of the mandibular teeth. The safest method of ensuring that excessive bone is not removed, or that adjacent teeth are not damaged, is to start bone removal at the cementoenamel junction of the tooth working apically while identifying and using the PDL spaces of the root as the mesial and distal limits of alveolectomy. In most cases, removal of 1/3 to ½ of the bone covering root(s) is sufficient to facilitate elevation of the tooth; however, in teeth with ankylosis or compromised peripheral bone, up to 75% of the buccal bone could be removed. Once the buccal bone is removed, outlining/widening the PDL space around the roots with a small round bur (#½, #1) will facilitate insertion of the luxator/elevator blade.

Rough bone margins left after tooth extraction are a source of discomfort and can cause delayed healing secondary to flap abrasion/laceration. A diamond bur (round, egg, barrel) is used to smooth sharp bone spicules and the alveolar bone margin (alveoloplasty).

Alveolar Wound Management

After tooth extraction, a bone curette is used to remove granulation and necrotic tissue from the alveolus; however, stripping the alveolus to the bone should be avoided since PDL remnants provide fibroblast for healing and contribute to angiogenesis and bone formation. Before wound closure, the extraction site should be flushed with a physiologic solution or water to remove loose debris, bacteria, and inflammatory mediators. Chlorhexidine rinsing should be avoided since it is toxic to fibroblasts.

The most commonly asked question about alveolar wound management is “What do you put into the alveolus?” What is taken out of the alveolus is far more important than what is put into the alveolus! According to Wolff’s Law of Bone Transformation, in the majority of patients a blood clot is all that is needed because the bone will heal and remodel to accommodate the forces placed upon it. Bone augmentation materials are actively marketed to veterinarians; however, none have been shown to improve the rate of healing or bone quality. These materials are designed to maintain the alveolar ridge height during healing which is rarely indicated in veterinary patients.
Alveolar Wound Healing Timeline

The oral cavity is very vascular and usually heals rapidly. Many studies in different species have described alveolar wound healing which is similar in all mammalian species studied.

- Day 1-3: Blot Clot
- Week 1: Granulation Tissue & Provisional Bone Matrix
- Week 2: Bone Replacement Begins
- Week 3: Epithelialization Complete
- Month 2: Bone Replacement Complete
- Month 6: Bone Remodeling Complete

Hemorrhage Control

Bleeding from the extraction site is usually temporary, and since bleeding disorders should be identified during the preoperative evaluation, excessive hemorrhage is almost always the result of poor technique secondary to impatience. If a major vessel is lacerated, it should be ligated since primary wound closure over a hemorrhaging blood vessel usually results in a large submucosal hematoma. Penetration of the mandibular canal and nasal passages with a bur or elevator can cause significant bleeding which can usually be controlled by packing the alveolus with gauze. If bleeding cannot be controlled using standard techniques, hemostatic products are available in liquid, powder, and sponge forms that can be closed into a wound; however, these products are typically inappropriate for cases of oronasal fistula. Bone wax can be used to control excessive hemorrhage from a bone surface.

Extraction of Fractured & Retained Root Tips

During oral examination and survey radiographs, veterinarians occasionally discover retained tooth roots. The veterinarian must determine whether the advantage gained by removing the root fragment is greater than the risk of tissue damage and complications from surgical extraction. If the root show no signs of infection or inflammation and is surrounded by healthy bone (“is quiet”), many veterinary dentists would elect to radiographically re-evaluate the root in the future.

The goal of exodontia is to extract the entire tooth; therefore, all tooth roots should be extracted, unless there is ankylosis of the root with no signs of infection or inflammatory disease. Retained roots are frequently infected with microscopic draining tracts, which is a continued source of discomfort for the patient. Root fragments are extracted with small instruments (root picks & forceps) using surgical techniques under magnification. If a root fracture occurs during extraction, a “moat” can be cut around the root with a ¼, ½, or 1 round bur to facilitate luxation and elevation with root tip instruments. Sometimes a gingival flap must be developed and alveolectomy performed to gain access to the root fragment. A dentist must work patiently to ensure that a root fragment is not pushed into the nasal cavity or mandibular canal. If a veterinarian determines that the risk of extraction is significant and purposefully leaves a retained or resorbed tooth root during extraction, this decision should be record in the dental chart (“Intentional Root Retention”), and the client informed of the possible sequella.
Extraction of Primary Teeth

Based upon the principle that *two teeth cannot occupy the same tooth position*, persistent primary teeth should be extracted if they are blocking the correct eruption of an adult tooth. Failure to extract persistent primary teeth in a timely manner often predisposes the patient to malocclusions and periodontal disease which requires more expensive corrective procedures as an adult. The roots of primary teeth are typically long, thin, and fragile with a crown to root ratio for primary canine teeth being 1:3. Root fracture is a common complication during extraction. Primary teeth can be *patiently* nonsurgically extracted using small luxators, elevators, and root tip instruments, but care should be taken to prevent damage the adult tooth. Many dentists prefer to surgically extract primary teeth because the outcome is more predictable.

Postoperative Care

The owner should be provided with written discharge instructions discussing the procedures performed, expected recovery & postoperative evaluations, medications dispensed (antibiotics, analgesics, anti-inflammatories), restrictions, and dietary guidelines. While highly debatable, the author does not routinely prescribe oral rinses postoperatively and is trending away from the use of postoperative antibiotics. The author typically prescribes the following:

1. 10 days of restriction from purposeful play or exercise, from chew toys & treats, and from oral hygiene. (A tooth sealant is applied to prevent plaque accumulation during this period.)
2. 7-10 days of softened food.
3. 10 days of anti-inflammatory medication.
4. 5-7 days of analgesic medication.
5. Oral evaluation appointment 10 days postoperatively.
The extractions of the canine and carnassial teeth are often difficult and associated with significant complications. Extraction of the maxillary canine tooth is associated with oronasal fistula. Extraction of the maxillary 4th premolar is associated with laceration of the infraorbital neurovascular structures and oronasal fistula. Extraction of the mandibular canine tooth and 1st molar are associated with fracture of the mandible. Extraction of the canine teeth can also cause maxillary lip entrapment and glossoptosis (lolling of the tongue). Due to the potential complications of the strategic tooth extraction, owners should be preoperatively counseled and encouraged to pursue tooth saving treatments. Successful extraction of these teeth requires the understanding and application of oral surgical principles for single, double, and three-rooted teeth. Specific techniques for extracting the canine and carnassial teeth in dogs will be reviewed in preparation for the afternoon wetlabs.

**Surgical Extraction of the Maxillary Canine Tooth (MX04)**

Surgical Anatomy: The root of the canine tooth has a prominent juga and extends distally over the 1st and 2nd premolars. The palatal alveolar bone is very thin and prone to fracture, creating an oronasal fistula, secondary to aggressive elevation. The lateral nasal branch of the infraorbital artery extends rostrally through the submucosal tissues over the juga of the canine tooth to the level of the 3rd incisor. Branches of the major palatine artery run from the palate to the buccal mucosal tissues between the 3rd incisor and canine tooth.

**Technique:**

1. Single releasing mucoperiosteal flap:
   a. A circumferential sulcular incision is made around the MX04 with a #15 blade to incise the gingival attachment.
   b. A horizontal releasing incision is made through the distal sulcus of the MX04, the interdental space, and the buccal sulcus of the MX05.
   c. A vertical releasing incision is cut in the interdental space 2-3mm mesial to the mesiobuccal line angle of the MX04. *With the wide interdental space between the MX03 and MX04, this flap design ensures closure over bone.* A stab incision is made to the bone, and the gingiva, mucosa, and periosteum are incised in a single stroke from the gingiva to the apical extent of the juga.
   d. Another horizontal releasing incision is made from the gingival aspect of the vertical releasing incision into the mesial sulcus of the MX04.
   e. A periosteal elevator is placed into the mucosal incision and under the periosteum. Using in a crab-walking motion, the flap is elevated from the bone in a distal and apical direction to expose the juga. Finesse, and sometimes sharp dissection, is required to elevate the mesial corner of the flap.

2. Tooth extraction:
   a. Approximately one-half of the bone covering the root is removed with an end-cutting carbide bur (round or pear bur) using “paint brush” strokes. The mesial and distal aspects of the root are outlined for luxator/elevator placement. A tissue forceps handle can be used to retract and protect the flap from the bur.
b. A luxator is wedged into the distal, palatal, and mesial PDL spaces to create space for elevator placement. Luxation pressure is held for 10-15 seconds.

c. An elevator is then placed into the mesial PDL space, advanced apically until it stops, and then rotated and held for 15 seconds to apply leverage. The elevator is advanced apically again and leverage applied.

d. The elevator is moved to the distal PDL space and the process is repeated.

e. Elevation is alternated between the mesial and distal PDL spaces until the distal root is finger loose. *Elevation from the palatal PDL space should be avoided since excessive force could cause a fracture of diseased nasal bone and an oronasal fistula in the apical area.*

f. Extraction forces are used to extrude the tooth using a gentle coronally directed, pulling and rotating force.

3. Alveolar Wound Management:

   a. A bone curette is used to remove granulation and necrotic tissue from the alveolus.

   b. A diamond bur (round, egg, barrel) is used to smooth sharp alveolar bone edges.

   c. The extraction site is flushed with a physiologic solution or water to remove all loose debris.

4. Wound Closure:

   a. *A radiograph is taken to confirm complete extraction BEFORE closure.*

   b. In preparation for flap closure, the palatal recipient epithelium and flap margin are debrided/freshened/trimmed using a diamond bur or scissors.

   c. The mesial and palatal recipient edges are elevated to provide purchase for the needle during closure of the flap.

   d. A periosteal releasing incision is performed to provide elasticity to the flap and ensure a tension free closure. Sharp scissors are used to bluntly dissect between the periosteum and the mucosa, and then the periosteum is cut at the base of the flap.

   e. A simple interrupted suture is placed at the caudal aspect of the flap between the gingiva and the palate to ensure a gingival collar is wrapped around the MX05, then a simple interrupted suture is placed to close the mesial corner of the flap.

   f. Once the corners of the flap are closed, the remainder of the flap and the mucosal releasing incision are closed by placing sutures 2 to 3 mm apart.

5. The occlusion of the ipsilateral MN04 is evaluated to ensure traumatic occlusion into the lip is not present. If maxillary lip entrapment is diagnosed, odontoplasty of the MN04 crown may be required.
Surgical Extraction of the Maxillary 4th Premolar (MX08)

Surgical Anatomy: The mesiobuccal and distal roots have prominent jugae. The infraorbital neurovascular structures exit the infraorbital foramen dorsal to the distal root of the maxillary third premolar and extends rostrally through the submucosal tissues. The salivary ducts (parotid, zygomatic, and minor) pass thru the vestibular mucosa, and the parotid papilla is located in the vicinity of the distal root of the MX08.

Technique:

1. Single releasing mucoperiosteal flap:
   a. A sulcular releasing incision is made with a #15 blade on the buccal aspect of the MX08 continuing distally through the interdental gingival papilla and into the buccal sulcus of the MX09. The palatal gingival attachment is released with a second sulcular incision to completely incise the gingival attachment around the MX08.
   b. A slightly diverging vertical releasing incision is cut along the mesiobuccal line angle of the MX08, preserving the interdental gingival papilla to ensure the MX07 has a complete gingival collar. A stab incision is made to the bone, and the gingiva, mucosa, and periosteum are incised in a single stroke from the gingiva to the apical extent of the mesiobuccal juga.
   c. A periosteal elevator is placed into the mucosal incision and under the periosteum. Using in a crab-walking motion, the flap is elevated from the bone in a distal and apical direction to expose the jugae of the mesiobuccal and distal roots.

2. Tooth sectioning and individual roots extraction:
   a. “Paint brush” strokes with an end-cutting carbide bur (round or pear bur), are used to remove 1/3 to ½ of the bone covering the mesiobuccal and distal roots. Bone is also removed from the furcation, and the roots are outlined for luxator/elevator placement.
   b. A cross-cut carbide bur (557, 701) is used to isolate the distal root by sectioning the MX08 between the two large cusps, cutting from the furcation coronally and palatally. Complete sectioning is verified by placing an elevator between the tooth sections and checking for mobility.
   c. Coronoplasty is performed on the distal cusp to allow instrument placement between the MX08 and MX09.
   d. A luxator is wedged into the distal and mesial PDL spaces of the distal root to create space for elevator placement. Luxation pressure is held for 10-15 seconds.
   e. An elevator is then placed into the distal PDL space, advanced apically until it stops, and then rotated and held for 15 seconds to apply leverage. The elevator is advanced apically again and leverage applied. The MX09 should NOT be used as a fulcrum.
   f. The elevator is moved to the mesial PDL space and the process is repeated. The mesial tooth section can be used as a fulcrum.
   g. Elevation is alternated between the mesial and distal PDL spaces until the distal root is slightly mobile. The distal root section is not extracted.
   h. Using the crosscut bur, the mesiobuccal and mesiopalatal roots are separated by sectioning the MX08 between mesiobuccal cusp and the palatine cusp, cutting
from the furcation coronally and distally. In large dogs this step may be facilitated by first removing the majority of the mesiobuccal cusp with a horizontal cut using a cross-cut fissure bur.

i. The mesiobuccal root is luxated and elevated as described above until finger loose. **The distal tooth section can be used as a fulcrum.**

j. Extraction forceps are used to extrude the tooth using a gentle coronally directed, pulling and rotating force.

k. The extracted root is examined to ensure complete extraction.

l. Using an end-cutting carbide bur (round or pear bur), the interradicular (furcation) bone around the mesiopalatal root is carefully removed, avoiding apical perforation through the palate.

m. The mesiopalatal root is luxated and elevated as described above until finger loose, extracted with forceps, and examined to ensure complete extraction.

n. The distal root is elevated as described above until finger loose, extracted with forceps, and examined to ensure complete extraction. If elevation is difficult, interradicular bone can be removed to facilitate luxation in the mesial direction.

3. Alveolar Wound Management: As described above for the surgical extraction of MX04.

4. Wound Closure: As described above for the surgical extraction of MX04.

**Surgical Extraction of the Mandibular Canine Tooth (MN04)**

Surgical Anatomy: The root of the canine tooth extends medioventrally to the roots of the 1st and 2nd premolar. The mental neurovascular structures extend rostrally through the submucosal tissues on the buccal aspect of the mandible from the middle mental foramen which is ventral to the 2nd premolar. Some veterinary dentists consider this the most difficult extraction.

Technique:

Three approaches to the MN04 are described. This technique is the buccal approach.

1. Single releasing mucoperiosteal flap:
   a. A circumferential sulcular incision is made around the MN04 with a #15 blade to incise the gingival attachment.
   b. A horizontal releasing incision is made through the distal sulcus of the MN04, the interdental space, and the buccal sulci of MN05 and MN06.
   c. A vertical releasing incision is cut from the mesiobuccal line angle of the MX04. A stab incision is made to the bone, and the gingiva, mucosa, and periosteum are incised in a single stroke from the gingiva to apical extent of the mesiobuccal root.
   d. A periosteal elevator is placed into the mucosal incision and under the periosteum. Using in a crab-walking motion, the flap is elevated from the bone in a distal and apical direction to expose the mandible.

2. Tooth extraction:
   a. Approximately one-half of the bone covering the root is removed with an end-cutting carbide bur (round or pear bur) using “paint brush” strokes. The mesial and distal aspects of the root are outlined for elevator placement.
   b. A luxator is wedged into the distal, lingual, and mesial PDL spaces to create space for elevator placement. Luxation pressure is held for 10-15 seconds.
c. An elevator is then placed into the mesial PDL space, advanced apically until it stops, and then rotated and held for 15 seconds to apply leverage. The elevator is advanced apically again and leverage applied.

d. The elevator is moved to the distal PDL space and the process is repeated.

e. Elevation is alternated between the mesial and distal PDL spaces until the distal root is finger loose.

f. Extraction forceps are used to extrude the tooth using a gentle coronally directed, pulling and rotating force.

g. The extracted root is examined to ensure complete extraction.

3. Alveolar Wound Management: As described above for the surgical extraction of MX04; however, it is usually easier to perform alveoloplasty on a mandibular tooth extraction site after the lingual recipient gingival edge has been elevated.

4. Wound Closure: As described above for the surgical extraction of MX04, except that the gingival papilla between MN05 and MN06 is closed with an interdental suture before the gingival collar is reestablished around the mesial aspect of the MN05. And after the mesial corner of the flap is sutured, the frenulum should be reattached as close as possible to its original position.

### Surgical Extraction of the Mandibular 1st Molar (MN08)

**Surgical Anatomy:** The roots of the MN08 lie in close (mediodorsal) proximity to the mandibular canal. The mesial root often has significant curvature, and the distal aspect of the mesial root has a groove that increases bone purchase. In small breed dogs, the roots often have significant dilaceration at the apex.

**Technique:**

1. Single releasing mucoperiosteal flap:
   a. A sulcular releasing incision is made with a #15 blade on the buccal aspect of the MN09 continuing distally through the interdental gingival papilla and into the buccal sulcus of the MN10. The lingual gingival attachment is released with a second sulcular incision to completely incise the gingival attachment around the MN09.

   b. A slightly diverging vertical releasing incision is cut along the mesiobuccal line angle of the MN09, preserving the interdental gingival papilla to ensure the MN08 has a complete gingival collar. A stab incision is made to the bone, and the gingiva, mucosa, and periosteum are incised in a single stroke from the gingiva to the expected apical extent of the mesiobuccal root.

   c. A periosteal elevator is placed into the mucosal incision and under the periosteum. Using in a crab-walking motion, the flap is elevated from the bone in a distal and apical direction to expose the mandible.

2. Tooth sectioning and individual roots extraction:
   a. “Paint brush” strokes with an end-cutting carbide bur (round or pear bur), are used to remove ½ to ¾ of the bone covering the roots. Bone is also removed from the furcation, and the roots are outlined for luxator/elevator placement.

   b. A cross-cut carbide bur (557, 701) is used to separate the roots by sectioning the MN09 between the central and distal cusps, cutting from the furcation...
distocoronally and palatally. Complete sectioning is verified by placing an 
elevator between the tooth sections and checking for mobility.
c. Coronoplasty may be performed on the mesial and distal cusps to allow 
instrument placement between the MN08 & MN09 and the MN09 & MN10, 
respectively. Additional coronoplasty to widen the sectioning cut or to remove 
part of the crown may facilitate instrument placement.
d. A luxator is wedged into the distal and mesial PDL spaces of each root to create 
space for elevator placement. Luxation pressure is held for 10-15 seconds.
e. An elevator is then placed into the distal PDL space of the distal root, advanced 
apically until it stops, and then rotated and held for 15 seconds to apply leverage. 
The elevator is advanced apically again and leverage applied. *The adjacent teeth 
should NOT be used as a fulcrum.*
f. The elevator is moved to the mesial PDL space, and the process is repeated. *The 
mesial tooth section can be used as a fulcrum.*
g. Elevation is alternated between the mesial and distal PDL spaces until the distal 
root is slightly mobile. *The distal root section is not extracted.*
h. The mesial root is elevated as described above until finger loose, extracted with 
forceps, and examined to ensure complete extraction.
i. The distal root is then elevated until finger loose, extracted with forceps, and 
examined to ensure complete extraction. If elevation is difficult, interradicular 
bone can be removed to facilitate luxation in the mesial direction.
3. Alveolar Wound Management: As described above for the surgical extraction of MN04.
4. Wound Closure: As described above for the surgical extraction of MX04.
Ticks

Ticks are eight-legged arachnids which feed on blood, causing nuisance biting and disease transmission in people and animals worldwide. There are approximately 900 species of ticks comprised of soft tick, hard ticks, and a group that has characteristics of both groups.

Rocky Mountain spotted fever

Ticks may transmit a wide variety of bacterial organisms, most notably rickettsiae, classified by scientists into several distinct groups. The spotted fever group (SFG) contains rickettsial species related to the agent of Rocky Mountain spotted fever (RMSF), *Rickettsia rickettsii*. But there are many other rickettsial species in the spotted fever group; it contains at least ten disease agents and 15 others with low or no pathogenicity to humans. RMSF is the most frequently reported rickettsial disease in the U.S. with about 1800 cases reported each year. Probably many more cases occur but go unreported. If an unusual febrile illness is treated successfully with doxycycline, there may be little interest in follow-up and reporting. At the time of initial presentation, there is often the classic triad of RMSF: fever, rash, and history of tick bite. Other characteristics are malaise, severe headache, chills, and myalgias. Sometimes, gastrointestinal symptoms such as abdominal pain and diarrhea are reported. More than one member of the family may be infected. The rash, appearing on the third day or after, usually begins on the extremities and then spreads to the rest of the body. However, there have been confirmed cases without rash. Mental confusion, coma, and death may occur in severe cases. Untreated, the mortality rate is about 20%; even with treatment, the rate is approximately 5%.

Ehrlichiosis and anaplasmosis

*Ehrlichia* and *Anaplasma* are organisms in the family Anaplasmataceae that primarily infect circulating leukocytes. Much of the knowledge gained concerning ehrlichiae has come from veterinary studies on *Anaplasma marginale* (cattle disease agent), *Ehrlichia (Cowdria) ruminantium* (cattle, sheep, goats), and *Ehrlichia equi* (horses). Canine ehrlichiosis, caused by *Ehrlichia canis*, wiped out 200 to 300 military working dogs during the Vietnam War. Ehrlichiosis in the U.S. is usually caused by 1-3 closely related Ehrlichia organisms as follows. One, *Ehrlichia chaffeensis*, the most frequently reported, is the causative agent of human monocytic ehrlichiosis (HME) which occurs mostly in the southern and southcentral U.S. (sporadic cases of HME have also been reported in Europe), and infects mononuclear phagocytes in blood and tissues. There were 944 cases of HME reported to the CDC in 2009. The second, *E. ewingii*, mostly a dog and deer pathogen, infects granulocytes and causes a clinical illness similar to HME. The third ehrlichial agent, *E. muris*-like (sometimes called EML), causes fever, malaise, headache, lymphopenia, and elevated liver enzymes in humans. Thus far, it has been reported from the upper midwestern U.S. and the agent is transmitted by the deer tick, *Ixodes scapularis*. 
Babesiosis

Human babesiosis is a malaria-like disease primarily associated with two protozoa of the family Piroplasmorida: *Babesia microti* and *Babesia divergens*, although other newly recognized species may also cause infection. The disease is a malaria-like syndrome characterized by fever, fatigue, and hemolytic anemia lasting from several days to a few months. In terms of clinical manifestations, babesiosis may vary widely, from asymptomatic infection to a severe, rapidly fatal disease.

Babesial parasites, along with members of the genus *Theileria*, are called piroplasms because of their pear-shaped intraerythrocytic stages. There are at least 100 species of tick-transmitted *Babesia* parasitizing a wide variety of vertebrate animals. Some notorious ones are as follows: *Babesia bigemina*, the causative agent of Texas cattle fever; *B. canis* and *B. gibsoni*, canine pathogens; *B. equi*, a horse pathogen that occasionally infects humans; *B. divergens*, a cattle parasite that infects humans; and *B. microti*, a rodent parasite that may infect humans.

Tularemia

Tularemia, sometimes called rabbit fever or deer fly fever, is a bacterial zoonosis occurring throughout temperate climates of the Northern Hemisphere. Approximately 150 to 300 human cases occur in the U.S. each year, but most cases occur in Arkansas, Missouri, and Oklahoma. The causative organism, *Francisella tularensis*, is a small, Gram-negative, nonmotile coccobacillus named after Sir Edward Francis (who did the classical early studies on the organism) and Tulare, CA (where it was first isolated). The disease may be contracted in a variety of ways: food, water, mud, articles of clothing, and (particularly) arthropod bites. Arthropods involved in transmission of tularemia include ticks, biting flies, and possibly even mosquitoes.

Colorado tick fever

Colorado tick fever (CTF) is a generally moderate, acute, self-limited, febrile illness occurring out West which is caused by a Coltivirus in the Reoviridae. Typically, onset of CTF is sudden, with chilly sensations, high fever, headache, photophobia, mild conjunctivitis, lethargy, myalgias, and arthralgias. At least in humans, the body temperature pattern may be biphasic, with a 2- to 3-d febrile period, a remission lasting 1- to 2-d, then another 2- to 3-d of fever, sometimes with more severe symptoms. Peak incidence is during April and May at lower elevations and during June and July at higher elevations. The virus is maintained in nature by cycles of infection among various small mammals and the ticks that parasitize them. Infection in humans is by the bite of an infected tick. Several tick species have been found infected with the virus, but *Dermacentor andersoni* is by far the most common. This tick is especially prevalent where there is brushy vegetation to provide good protection for small mammalian hosts of immature ticks and yet with sufficient forage to attract large hosts required for the adults.

Relapsing fever

Tick-borne (endemic) relapsing fever (TBRF) is a systemic spirochetal disease characterized by periods of fever lasting 2 to 9 d alternating with afebrile periods of 2 to 4 d. The total number of relapses can vary from 1 to 10 or more, lasting 2 or 3 weeks. Transitory petechial rashes are common during the initial febrile period. Untreated, the mortality rate is between 2 and 10%.
TBRF is caused by a variety of tick-adapted *Borrelia* species (some researchers say that all of the tick-adapted strains are really just one species). The spirochetes are transmitted to humans and animals by several species of soft ticks in the genus *Ornithodoros*. Several hundred cases of TBRF are reported worldwide each year, with approximately 30 to 50 of those being diagnosed in the U.S. (primarily in Washington, Oregon, and northern California).

**Tick-borne encephalitis**

The term tick-borne encephalitis (TBE) generally describes disease entities caused by several subtypes of a flavivirus: European tick-borne encephalitis (TBEV-Eur), Siberian (TBEV-Sib), and Far Eastern (TBEV-FE). However, there are a couple of these agents occurring in the Western Hemisphere such as Powassan encephalitis and deer tick encephalitis. Powassan encephalitis (POW) is a rare infection of humans that mostly occurs in the northeastern U.S., adjacent regions of Canada, and parts of Russia. POW causes sudden onset of fever with temperature up to 40°C along with convulsions. Also, accompanying encephalitis is usually severe, characterized by vomiting, respiratory distress, and prolonged, sustained fever. Only about 35 cases of POW have been reported in North America, although its reported incidence may be increasing. Recognized cases have occurred in children and adults, with a case fatality rate of approximately 50%. POW is transmitted in an enzootic cycle among ticks (primarily *Ixodes cookei* and rodents and carnivores. *Ixodes cookei* only occasionally bites people; this may explain the low case numbers. Antibody prevalence to POW in residents of affected areas is less than 1%, indicating that human exposure to the virus life cycle is a rare event.

Deer tick encephalitis, closely related to POW, is another clinical entity in the TBE complex which was first discovered in North America in the late 1990's. Few clinical cases have ever been described, although at least one death has been attributed to this virus. The agent has been found along the Atlantic Coast and in Wisconsin and is primarily associated with the deer tick, *Ixodes scapularis*.

**Tick paralysis**

Tick paralysis can occur in people or animals and is characterized by an acute, ascending, flaccid motor paralysis that may terminate fatally if the tick is not located and removed. The causative agent is believed to be a salivary toxin produced by ticks when they feed. In the strictest sense, tick paralysis is not a zoonosis; however, many contend that zoonoses should include not only infections that humans acquire from animals, but also diseases induced by noninfective agents such as toxins and poisons. The disease is more common than one might think. In North America, hundreds of cases have been documented from the Montana–British Columbia region. It occurs in the southeastern U.S. as well. Tick paralysis is also especially common in Australia. Sporadic cases may occur in Europe, Africa, and South America.

2. **Mosquitoes**

Mosquitoes are second only to ticks as disease transmitters to animals. These blood-sucking insects cause significant annoyance and disease in animals worldwide. About 3,500 species of mosquitoes have been described worldwide. Relatively few of them are significant vectors of animal diseases; however, the mosquito-transmitted disease problem among animals worldwide is quite severe.
Filarial worms

Many different types of filarial worms are transmitted to humans and other mammals by mosquitoes and black flies. Examples include the causative agents of Bancroftian and Malayan filariasis, loiasis, onchocerciasis, and dirofilariasis (dog heartworm). Other filarial worms may or may not cause symptomatic disease and are less well known (and thus have no common name), such as Mansonella ozzardi, M. streptocerca, M. perstans, Dirofilaria tenuis, D. ursi, D. repens, and others.

The dog heartworm, *Dirofilaria immitis*, occurs mainly in the tropics and subtropics but also extends into southern Europe and North America. This worm infects several canid species, sometimes cats, and, rarely, humans. Numerous mosquito species are capable of transmitting dog heartworm, especially those in the genera *Aedes, Ochlerotatus, Anopheles*, and *Culex*. Mosquitoes pick up the microfilariae with their blood meal when feeding on infected dogs. In endemic areas, a fairly high infection rate may occur in local mosquitoes. The closely related *D. tenuis* is commonly found in the subcutaneous tissues of raccoons (again, mosquito-transmitted) and may accidentally infest humans as nodules in subcutaneous tissues.

Viruses transmitted by mosquitoes

In temperate North America, the most common mosquito-borne diseases are probably the encephalitides. Certainly not all cases of encephalitis are mosquito-caused (enteroviruses and other agents are often involved), but mosquito-borne encephalitis has the potential to become a serious cause of morbidity and mortality covering widespread geographic areas each year.

Eastern equine encephalomyelitis (EEE) is generally the most virulent, being severe and frequently fatal (mortality rate 30 to 60%) in horses and humans. Fortunately, large and widespread outbreaks are not common; between 1961 and 1985 only 99 human cases were reported. EEE occurs in late summer and early fall in the central and north central U.S., parts of Canada, southward along the coastal margins of the eastern U.S. and the Gulf of Mexico, and sparsely throughout Central and South America. Horses are especially susceptible to EEE infection and may serve as sentinel animals to indicate virus activity in an area. However, widespread use of the eastern-western-tetanus vaccine may bias surveys of horse cases of EEE. Recently, human cases of EEE seem to be occurring more northeasterly into Maine and Vermont. The ecology of EEE is complex. The virus circulates in wild bird populations, and the exact mosquito vectors responsible for spread to humans are not well known. Some species likely involved include *Ochlerotatus sollicitans, Coquillettidia perturbans, Culex salinarius*, and *Ae. vexans*, although certain *Anopheles* species may serve as bridge vectors during epizootics.

The West Nile virus (WNV) was identified for the first time in the Western Hemisphere in New York in 1999. By the end of the year, it had caused encephalitis in 62 people and numerous horses in and around New York City, resulting in 7 human and 10 equine deaths. The virus has continued to spread in subsequent years to all the continental United States, at least 7 Canadian provinces, Mexico, the Caribbean, and portions of South America. As far as severity of the disease, WNV is similar to SLE (one of our “native” encephalitis viruses). Approximately 80% of all WNV infections are asymptomatic, approximately 20% cause West Nile fever, and less than 1% cause West Nile neuroinvasive disease. From 1999-2005, more than 8,000 cases of neuroinvasive WNV disease were reported in the U.S., resulting in over 780 deaths. However, in recent years, there has been a decline in WNV case numbers. In 2009, there were only 720 cases nationwide reported to the CDC. As with SLE, WNV is more dangerous to older patients; people...
in the 60-89 age range are particularly at risk. Ecologically, WNV is a bird disease transmitted from bird-to-bird by various species of mosquitoes. The house sparrow has been found to be one of the best amplifying hosts in nature, producing highest viremias for the longest period of time. Although the virus has been isolated from many mosquito species, the main vectors to humans are believed to be *Culex pipiens*, *Cx. quinquefasciatus*, *Cx. salinarius*, *Cx. restuans*, and *Cx. tarsalis*.

3. Mites

Mites are tiny arachnids, closely related to ticks, which are mostly free-living, but a few species are parasitic. Mites are fairly notorious in the veterinary sciences due to their association with poultry and also as causes of mange.

**Northern fowl mite**

*Ornithonyssus sylviarum* also is similar in appearance to the tropical rat mite but has a much shorter sternal plate. This plate has only four setae; the setae on the dorsal plate are quite short. The northern fowl mite is a pest of domestic fowl, pigeons, sparrows, and starlings. The species overwinters in bird nests or cracks and crevices of buildings. Unlike the chicken mite, *D. gallinae*, the northern fowl mite spends its entire life on the host. In poultry houses the mites are usually only found on the birds, but they have been found on eggs and cage litter. Northern fowl mites cannot survive more than a month or so in the absence of their poultry hosts. The northern fowl mite occurs in temperate regions worldwide.

**Chicken mite**

*Dermanyssus gallinae*, the chicken mite, also known as the red mite of poultry, is commonly found on domestic fowl, pigeons, English sparrows, starlings, and other birds. This mite is one of the most common species causing human dermatitis in poultry houses, farms, ranches, and markets where chickens are traded or sold. Poultry workers are often bitten on the backs of the hands and on the forearms. *D. gallinae* is nocturnal; during the day the mites hide in cracks and crevices in chicken houses or buildings where infested birds nest. Eggs are deposited in these hiding places. The chicken mite occurs worldwide.

**Cheyletid mite**

The mite family Cheyletidae includes species in the genera *Cheyleta* and *Cheyletiella*. *Cheyletiella yasguri*, *C. blakei*, and *C. parasitivorax* have fused cheliceral bases further fused with the subcapitulum forming a capsular gnathosoma. This makes it look as though they are wearing a helmet. They have free and highly developed palpi with strong curved claws that look like an extra pair of legs near the mouthparts. *Cheyletiella* mites are parasites of birds and various species of small mammals. The Cheyletiella spp. mentioned in this section are obligate parasites of small- or medium-sized mammals (including pet dogs, cats, and pet rabbits), living on the keratin layer of the epidermis; they do not burrow. These mites may cause a mangelike condition on pets and a transient itching dermatitis on humans who handle these pets.

**Scabies mites**

Scabies, caused by *Sarcoptes scabei*, is probably the most important disease caused by mites, with at least 300 million cases annually. It occurs worldwide, affecting all races and socioeconomic classes in all climates. The tiny mites burrow under the skin, leaving small open sores and linear burrows that contain the mites and their eggs. When a person is infested with
scabies mites for the first time, there is little pathology for about a month, until sensitization develops. When that happens, there is severe itching, especially at night and frequently over much of the body. Large patches of erythema or rash may occur on the body. The patient’s tissues apparently become sensitized to various proteins liberated by the mites. Interestingly, the generalized rash may not correspond to the sites where the mites are burrowing. In humans, the burrows are usually located on the hands, wrists, and elbows, especially in the webbing between the fingers and the folds of the wrists.

It should be noted here that animal forms of scabies such as canine or equine are also caused by “races” of S. scabei (sometimes with devastating results), but these mites cannot propagate in human skin. Canine scabies can be temporarily transferred to humans from dogs, causing itching and papular or vesicular lesions primarily on the waist, chest, or forearms. However, treatment or removal of the infested dog will result in a gradual resolution of this type of scabies.

Sarcoptes scabei are very tiny (0.2 to 0.4 mm long), oval, sac-like, eyeless mites. Their legs are rudimentary; the anterior two pairs have bell-shaped suckers on their tips. The body is covered with striations and has several stout blunt spines and a few long setae. Scabies mite mouthparts are composed of toothed chelicerae and one-segmented palps fused to the central hypostome. Nymphs look almost identical to the adults, except that they are smaller.

Although there are numerous species of Demodex (family Demodecidae) infesting wild and domestic animals, only two species of the mites are specific human-associated mites and are called follicle mites. The minute, wormlike mites live exclusively in hair follicles or sebaceous glands. They have no proven detrimental effect on humans, although some authors have attributed various pathological conditions of the skin to Demodex. For humans, Demodex is a harmless saprophyte. It is only exceptionally that it appears to exercise a pathogenic influence, as, for example, when excessive amounts of cosmetics prepare the ground for its proliferation or when it escapes into the dermis.” Various estimates of the incidence of human Demodex infestation range from about 25 to 100%, and clinicians should be aware of mite appearance, as they may be seen during skin-scraping examination.

**Follicle mites**

*Demodex folliculorum* lives in the hair follicles and *D. brevis* in the sebaceous glands. Both species are similar in appearance (with the exception that *D. brevis* is a shortened form) and are elongated, wormlike mites with only rudimentary legs. They are approximately 0.1 to 0.4 mm long and have transverse striations over much of the body. These mites most commonly occur on the forehead, malar areas of the cheeks, nose and nasolabial fold, but they can occur anywhere on the face, around the ears, and occasionally elsewhere. Most people acquire *Demodex* mites early in life from household contacts — primarily maternal.

**4. Fleas**

Fleas are small, laterally flattened, wingless insects that are of great importance as vectors of disease in many parts of the world. Public health workers are most concerned with fleas that carry the agents of bubonic plague and murine typhus from rats to people and fleas that transmit plague among wild rodents and secondarily to humans. However, there are other fleaborne diseases. *Rickettsia felis*, a member of a transitional group of rickettsiae, has been found worldwide in cat fleas and can apparently infect humans, producing a murine typhuslike illness. Certain rodent fleas are efficient vectors of *Bartonella* organisms. Also, fleas may serve as intermediate hosts for helminths like the dog tapeworm. Despite these disease threats, for many
people (especially the lay public), the insidious attacks by fleas on people and domestic animals causing irritation, blood loss, and severe discomfort are equal in importance to disease transmission. Two species of fleas are often seen in veterinary practice.

**Cat and Dog Fleas, *Ctenocephalides felis* and *C. canis***

Cat fleas are the fleas most often encountered by people in the U.S. (the dog flea is relatively rare in North America). Contrary to their name designation, dog fleas may feed on cats and cat fleas on dogs. In fact, in many areas the predominant flea species infesting dogs is the cat flea. Both species are mainly just pest species, although there is some evidence that cat fleas may transmit *Rickettsia felis* to humans. In addition, cat fleas are intermediate hosts of the dog tapeworm, *Dipylidium caninum*, and their bites may produce papular urticaria. Children sometimes become infected via close contact with a flea-infested dog.

**Sticktight Flea, *Echidnophaga gallinacea***

This flea, sometimes called the hen flea, is primarily a pest of poultry, but humans are often attacked. As with the chigoe flea, *E. gallinacea* attaches firmly to its host and engorges with blood. It may remain embedded in the integument of the host for some time. Chickens frequently have dark flea-covered patches around the eyes, comb, or wattles.

**5. Flies**

Flies are two-winged insects in the insect order Diptera. Most flies are non-biting, but some are notorious veterinary pests causing millions of dollars in damage to agricultural operations.

**Black flies**

Black flies (also called buffalo gnats, turkey gnats, and Kolumbtz flies) are small, humpbacked flies that are important as vectors of disease and as nuisance pests. In the tropics, black flies are vectors of the parasite, *Onchocerca volvulus*, which causes a chronic nonfatal disease with fibrous nodules in subcutaneous tissues and sometimes visual disturbances and blindness (river blindness). The World Health Organization estimates that about 17.7 million people have onchocerciasis in Africa and Latin America, with approximately 270,000 cases of microfilarial-induced blindness and another 500,000 people with severe visual impairment. Since 1987 onchocerciasis control has been greatly aided by donations of Mectizan® brand of ivermectin (Merck and Co.) which has been a gold-standard anti-parasitic drug. However, resistance to ivermectin has recently been reported, forcing reconsideration of other drugs and strategies in a more integrated approach.

**Deer flies**

Deer flies belong to the family Tabanidae (the same one as horse flies) but are usually much smaller. Deer flies are extremely annoying to people in the outdoors during summer months, often circling persistently around the head. Like horse flies, deer flies have scissorlike mouthparts and can inflict painful bites. Deer fly bites often become secondarily infected; in hypersensitive individuals they have been known to produce systemic reactions characterized by generalized urticaria and wheezing. In the U.S., the deer fly *Chrysops discalis* mechanically transmits tularemia organisms from rabbits to people by its bites, a condition sometimes called deer-fly fever. In a recent outbreak, 64% of human cases of tularemia in Wyoming were attributed to deer
fly bites. In the African equatorial rain forest, deer flies (particularly *C. silacea* and *C. dimidiata*) transmit the filarial parasite *Loa loa*. **Loiasis** affects an estimated 2 to 13 million individuals and is characterized by Calabar swellings (localized nonpitting edema mainly on the wrists or ankles, 5 to 20 cm in diameter, lasting from a few hours to a few days), generalized pruritus, arthralgia, fatigue, hypereosinophilia, and sometimes serious central nervous system (CNS) involvement. The pathognomonic symptom of loiasis, subconjunctival migration of the worm in the eye, is uncommon but still reported.

**Horse flies**
Horse flies (also family Tabanidae) are large, robust bloodsucking flies that are notorious pests of horses, cattle, deer, and other mammals. Several species of horse flies will also attack people. Horse fly bites have been known to produce systemic reactions in humans characterized by generalized urticaria and wheezing. Horse flies look like giant robust house flies. They are often 20 to 25 mm long and have large prominent eyes. Some species are called **green heads** because of their big green eyes. The antennae have only three sections. Their proboscis projects forward, and the female’s mouthparts are bladelike for a slashing/lapping feeding method. Horse fly larvae are spindle-shaped and generally white, tan, brown, or even greenish in color.

Horse fly bites are generally few and self-limiting. If secondary infection/cellulitis develops, appropriate systemic antibiotics are indicated. Antiseptic and soothing lotions may relieve pain and itching. Allergic reactions characterized by hives, wheezing, and widespread urticaria require intensive evaluation and treatment. If the reaction is mild, oral antihistamine therapy may suffice, but severe reactions involving shock will probably require epinephrine.

**Biting gnats**
The biting midges are very tiny slender gnats in the family Ceratopogonidae; they are sometimes called punkies, no-see-ums, gnats, or flying teeth. Adult biting midges are vicious and persistent biters, and some persons have strong reactions to their bites. Their small size allows them to pass through ordinary screen wire used to cover windows and doors. These tiny insects are generally not involved in the transmission of disease agents to humans in the U.S. However, in Africa and South America certain species may be able to transmit filariae, protozoa, and viruses (particularly Shuni and Oropouche viruses in the Simbu serogroup of arboviruses).

Biting midges are typically gray in color (although some species may be yellowish), extremely small, 0.6 to 1.5 mm, and delicate with narrow wings that have few veins and no scales. The wings may be clear or hairy, sometimes distinctly spotted (with pigment, not scales as in mosquitoes), and folded scissorlike over the abdomen at rest. The eyes on each side of the head are black and the proboscis protrudes forward and downward. Biting midges somewhat resemble other small species of nonbiting gnats in the family Chironomidae, but they are not as large and mosquito-like as chironomids. Swarms of biting midges are small and inconspicuous. People attacked by this midge will often comment when outdoors, “Something is biting me but I can’t see what it is.”

**Sand flies**
Sand flies are tiny bloodsucking flies in the family Psychodidae that transmit the causative agents of **bartonellosis** (Carrión’s disease), **sand fly fever**, and **leishmaniasis**. Sand fly fever, a viral disease, occurs in those parts of southern Europe, the Mediterranean, the Near and Middle East, Asia, and Central and South America where the Phlebotomus vectors exist. Bartonellosis
caused by the bacillus, *Bartonella bacilliformis*, occurs in the mountain valleys of Peru, Ecuador, and southwest Colombia. Leishmaniasis occurs in tropical and subtropical areas over much of the world. There has been a recent resurgence of leishmaniasis. Clinically, leishmaniasis manifests itself in four main forms: (1) cutaneous, (2) mucocutaneous, (3) diffuse cutaneous, and (4) visceral. The cutaneous form may appear as small and self-limiting ulcers that are slow to heal. When there is destruction of nasal and oral mucosa, the disease is labeled mucocutaneous leishmaniasis. Sometimes there are widespread cutaneous papules or nodules all over the body, a condition termed diffuse cutaneous leishmaniasis. Finally, the condition in which the parasites invade cells of the spleen, bone marrow, and liver — causing widespread visceral involvement — is termed visceral leishmaniasis or kala azar. There have been reports of visceral leishmaniasis in foxhounds in the U.S., but the only human sand fly-transmitted disease in the U.S. is probably the few cases of cutaneous leishmaniasis diagnosed each year in south Texas.

**Stable flies**
The stable fly, *Stomoxys calcitrans*, is a significant medical and veterinary pest. People who say “a house fly bit me” are usually mistakenly referring to the stable fly. The flies (sometimes also called dog flies) are fierce biters of people, pets, and livestock, and are a major pest in some seacoast areas, impeding development. Because of their bloodsucking habits, the flies have been suspected of transmitting a number of human diseases by mechanical action, but proof is lacking.

Stable flies are 5 to 6 mm long, have a dull gray thorax with four dark longitudinal stripes, and have a dull gray abdomen with dark spots. They look very similar to house flies, but they are slightly larger and have a rigid proboscis projecting forward in a bayonet-like fashion. In contrast, house flies have sponging mouthparts that project downward.

**Tsetse flies**
There are over 20 species of flies in the genus *Glossina* that are called tsetse flies. Tsetse flies are 7 to 13 mm long and yellow, brown, or black. They fold their wings scissorlike over their back at rest, and this, along with other body features, makes them appear wasp- or honey bee-like. Most of the species are vectors of trypanosomes of people and animals; however, at least six species are of primary importance as vectors of African trypanosomiasis, caused by subspecies of the protozoan, *Trypanosoma brucei*. The disease is called **sleeping sickness** because meningoencephalitis associated with the disease causes apathy, fatigability, confusion, and somnolence. The patient may gradually become more and more difficult to arouse and finally becomes comatose. In 1998, the WHO estimated that at least 300,000 cases of African trypanosomiasis were undiagnosed and untreated. However, intensive tsetse fly trapping and control, as well as case surveillance/treatment, brought the number of cases in 2009 to below 10,000 for the first time in 50 years.

**6. Fly larvae that may cause problems in people and animals**

**Bot flies**
The condition of fly larvae occurring in human tissues is called **myiasis**. Some fly larvae develop in living flesh; the human bot fly is one of them. This fly, *Dermatobia hominis*, is a parasite of humans, cattle, swine, cats, dogs, horses, sheep, other mammals, and a few birds in Mexico and Central and South America. The larvae burrow into the host’s tissues, feeding and eventually emerging to drop to the ground and pupate. In people, the larvae have been recovered from the
head, arms, back, abdomen, buttocks, thighs, and axilla. Human infestation is often characterized by painful discharging cutaneous swellings on the body. The condition is rarely fatal, except possibly in very young children (less than 5 years old); the larvae infesting the scalp penetrate into the incompletely ossified skull and enter the brain. Although the parasite does not occur in the U.S., cases are occasionally seen in travelers to endemic areas. One such case was reported from Ohio in which a local physician submitted a second-stage larva to the Ohio Department of Health for identification. The larva had been removed from a patient who had recently returned from Brazil.

*D. hominis* does not occur in the U.S., but is common in parts of Mexico and Central and South America. Sancho reports its distribution from the northern provinces of Mexico (Taumalipas, bordering southern Texas) to the northern Argentine provinces of Misiones, Tres Rios, Corrientes, and Formosa — roughly between latitudes 25° N and 32° S. Vacationers may acquire this parasite in tropical America, and return home before completion of maggot development.

**Screwworm flies**

Two important species of screwworm flies that feed in living tissues are *Chrysomya bezziana*, the Old World screwworm, and *Cochliomyia hominivorax*, the New World screwworm. Larvae of these calliphorid flies, called **screwworms**, are obligate parasites of living flesh (humans and domestic and wild mammals), feeding during their entire larval period inside a host. Screwworms feed by the hundreds close together, making pockets in the live flesh, eating downward with their pointed ends (the head end), and leaving their rear ends exposed for breathing. Infested wounds give off a sickening odor and ooze blood continually.

Female flies most often oviposit on or near a wound. However, human infestations have resulted from the flies ovipositing just inside the nostril while a person sleeps during the day, especially if there is a nasal discharge. Upon hatching, the larvae begin feeding, causing extensive destruction of tissue and a bloody discharge. Tissues around the lesion become swollen and pockets may be eaten out beneath the skin. The frontal and ethmoid sinuses may be entered and the cartilage and even the bone attacked. Infested persons may die from tissue destruction. Human cases are uncommon, but have occurred in areas where screwworm infestations occur in livestock. In 1935 there were 55 reported cases during a large outbreak among livestock in Texas. Because the New World screwworm fly has been eradicated from the U.S., human cases are rare and mostly due to foreign travel (there has been a recent outbreak of the New World screwworm in the Florida Keys).

Females of both screwworm species are attracted to wounds in mammals and lay eggs at the edge of the wounds. Eggs are deposited in batches of 150 to 400 and hatch approximately 15 h later. The larvae feed while embedded inside living tissue; sometimes, however, the peritremes (the plate surrounding the breathing tubes) are visible. The larvae emerge from the host as prepupae 4 to 7 d later and fall to the ground, where they pupate for a week or more. The entire life cycle from egg to egg takes about 24 d under optimum conditions. Adult screwworm flies are active all year round but only fly during daylight.

**Flesh flies (Family Sarcophagidae)**

Two important sarcophagid flies that cause myiasis are *Wohlfahrtia magnifica* and *W. vigil*. The *Wohlfahrtia* spp. look very similar to flesh fly adults (*Sarcophaga*), but instead of the checkerboard pattern on their abdomen they have clearly defined spots.
Small Animal

*W. magnifica* larvae produce traumatic myiasis throughout their host’s tissues, much like a screwworm fly. Tissues usually affected most commonly include the nose, ears, and eyes, and may result in deafness, blindness, or facial disfiguration. Human fatalities due to this species have been reported. *W. vigil* larvae are not as invasive; they are usually limited to dermal tissues, producing a furuncular or boil-like lesion.

7. **Other flies that might cause myiasis**

Larvae of flies in the genus *Cuterebra*, often found in squirrels (called wolves) and rabbits, may rarely parasitize humans, forming a warblelike dermal tumor. In a case the author consulted on, a 3-year-old boy had two *Cuterebra* larvae — on his side and neck — forming boil-like lesions. Several health care providers examined the boy and either diagnosed the lesions as boils or larval migrans (from dog hookworm), because there were short migration trails visible in the skin. To everyone’s surprise, one physician finally recognized the myiasis and expressed a larva from the neck lesion.

Other flies may occasionally cause myiasis in humans. This behavior is termed facultative myiasis. In some of these cases the larvae enter living tissues after feeding in neglected, malodorous wounds. In other cases, ports of entry include natural orifices such as the ears, urinary opening, or anus. Sometimes these fly larvae can be identified by looking at the shape and pattern of their posterior spiracles.

One of the most commonly implicated fly groups is the Calliphoridae (blow flies). Several species of blow flies, and especially *Lucilia sericata* and *Phormia regina*, have been reported to cause facultative myiasis in humans. *Lucilia sericata* is a typical-looking blow fly — shiny green or coppery green. *Phormia regina*, also called the black blow fly, is more slender and is olive-colored or nearly black.

*Lucilia sericata* is nearly cosmopolitan in distribution and is probably the most abundant species of *Lucilia* in North America. *Phormia regina* is Holarctic in distribution. One study found *Phormia regina* to be the most common blow fly in Mississippi, with specimens encountered throughout the year (peak numbers occurring in April and September).

Other specific comments on these two species are presented here. *Lucilia sericata* is a species that is quick to appear at fresh carrion, although it is also attracted to a wide range of decaying substances. In many cases, facultative myiasis cases seem to be the result of *Lucilia sericata* being attracted to festering and malodorous wounds with subsequent invasion of healthy human tissue. *Phormia regina* is very common throughout the U.S. during the warmer months (April to September). It is also abundant near a wide variety of decaying substances, especially carrion.
CLIPPERS, CLIPPER BLADES AND DRYERS

The focus of this lecture is to give information about the care, maintenance and basic repair of clippers, blades, shears and dryers. The format will be to give basic information and have a portion to answer and discuss specific questions and problems brought up by lecture participants.

SHEARS

We are mainly going to discuss surgical shears and instruments. After using surgical shears, they are usually sanitized. While this will not affect the shears, it will remove all lubrication. To prolong the service life of shears, it is important to keep them well lubricated. Any type of light oil will do this well. I have found that using a silicone rag, purchased from a sporting goods store, does a good job for cleaning and lubricating shears.

Another common shear problem is dropping. Many people feel if they drop a shear, it needs to be picked up and sent to be sharpened. Before sending a shear off after dropping, pick it up to see if it still cuts. This could save you a lot of time and money.

Dryers

There are two basic types of pet dryers. A force dryer usually has a hose and the motor or motors have carbon brushes that will need to be replaced. Most of the time, these dryers are run until they stop. While this is ok to do, you will probably get a longer life out of the motors if you set up a schedule to have the brushes replaced before they wear completely out. Probably at a six to nine month interval, depending on how hard the dryer is used.

The second type dryer has a brushless motor. While these dryers, for the most part do not blow as hard; they generally are lower maintenance than a force dryer. Also, most of these dryers have heating elements where force dryers usually produce heat by pulling air through the motor. It is important on all dryers to keep the air intake area clean of hair, and dirt. This allows strong air flow and helps to extend life of the heating elements and motors.

A common problem with all dryers is the plug on the end of the cord getting hot and wearing out. Dryers draw a lot of wattage. This produces heat, which causes the failure. The only way I have found to slow the failure of the cord plug is to have the dryer plugged into a 20-amp outlet with a heavy-duty plug on the cord. This will extend the life of the plug, but from my experience, it will still eventually fail.

Clippers and Blades

I have combined clippers and blades because, while they both have specific needs and problems, neither will work if they are not both functioning properly. A sharp blade will not cut if your clipper is worn so that the blade cannot take a full, strong stroke, and a new clipper won’t work if your blades are in poor condition.

We are going to cover mainly Oster and Andis clippers, but I will answer any questions about other clippers that come up. Oster clippers (A-5 and Turbo A-5) are
work horse clippers. These clippers do have regular service that needs to be preformed. If you are not getting a clean cut, leaving a pattern that looks like corduroy, the clipper probably has wear in the link and lever. If these two parts are replaced along with a little grease, the problem usually will be remedied. Brushes also need to be replaced in these clippers regularly. You will know brushes are worn out, because the clipper will start to spuddied and stop. When they first stop. If you tap on the side of the clipper, it will run briefly and stop again.

Another problem with Oster clippers is the switch nut falls off and then the switch wires brake. Look at the black nut around the switch regularly and make sure it is tight.

The final common problem with these clippers is the hinge screws work loose. If all you blades rattle, won’t snap down or are generally loud, make sure the two screws that hold the hinge on the clipper are tight.

Andis clippers run more quietly than Oster clippers, but they are more sensitive to over lubricating when cleaning. It is very important to clean and oil ONLY the blades on Andis clippers. If any type liquid gets into an Andis motor, you run the risk of shorting out the switch and armature. To repair this damage is usually $70.00 to $75.00.

General maintenance of an Andis clipper consists of replacing the blade drive and hinge. The hinge needs to be replaced when it will no longer hold the blades tightly to the clipper. The most common signs that the drives need replacing are the clipper seems to be running slower than normal and sharp blades seem to be dragging.

Cordless Clippers

Oster and Andis cordless clippers have mostly the same issues as other clippers with one exception. Most of the complaints with these clippers are that the batteries wont hold a charge. Blades that are not lubricated will put a heavy load on battery-operated clippers and cause the battery life to be greatly diminished. Make sure that blades are properly lubricated after they are disinfected.

Blades

Blades should be oiled several times per day. It would not be a bad practice to lubricate blades before each use. A light coat of lubricating spray should work well for frequent lubricating. At the end of the day, when the blades will no longer be used, using several drops of liquid oil will assure that the blades will work properly the next day.
While the number of cats kept as companions in North American homes is increasing, the number of feline visits to clinics has been declining since 2001. Based on the AVMA’s 2007 pet ownership and demographics survey, there are 13% more cats than dogs, yet cats fail to receive the same degree of veterinary attention. In small-animal practices, dogs represented 59% of office visits, cats only 39%. The 2011 Bayer Brakke study further noted three client-driven factors that limited the number of feline visits.

1. Inadequate understanding of the need for regular preventive health visits other than for vaccination.
2. Resistance to bringing a cat to the clinic because of the distress caused by placing a cat into a carrier and making the trip to the clinic.
3. The cost of veterinary care, in particular the frequency and size of price increases. (The economy is a separate, external factor.)

In November 2012, an online survey of 401 veterinary practice owners was conducted across the USA. The Bayer Veterinary Care Usage Study III: Feline Findings noted that 78% of veterinarians believed that better care for cats represented one of the most significant, missed opportunities for the profession. Yet, while 70% of veterinarians were familiar with the earlier Bayer-Brakke studies, and while most veterinarians recognize that cat owners consider a clinic visit to be stressful for themselves and their cats, nearly one-third of practices do not have staff trained on how to make visits less stressful for clients. Additionally, relatively few practices have adopted procedures such as: exam rooms used only for cats (35%); cat-only waiting areas that are physically and visually separated from dogs (18%); and cat-only days and appointment hours (11%) The study found that 46% of veterinary clinics surveyed had recently started taking specific steps to increase visits among current feline patients, attract more cat-owning clients, and make their practices more "cat friendly.

Part of the lack of awareness (at best) or reluctance (at worst) for making simple, inexpensive changes in attitude and facility is that many veterinarians and veterinary staff members prefer, or feel more comfortable, working with dogs than cats. Veterinarians also indicated that dogs are easier to diagnose.

The goal of this presentation is to look at practical steps to overcome these obstacles to routine veterinary care for cats in order to benefit cats and their human companions with resulting benefit of clinic growth.

**IMPROVING CLIENT COMPLIANCE**

The verb “to comply” means to act in accordance with a wish or command (Oxford), to conform, submit, or adapt (as to a regulation or to another's wishes) as required or requested (Miriam-Webster). For clients to comply with our recommendations, they have to fully understand and be able to perform desired actions. We need to engage them in the importance of these actions.
Thus, understanding (education) and on-going caring communication are needed to enhance client compliance.

Many clients believe that cats are self-sufficient, have very few needs, and are low maintenance pets. They don’t understand that cats live as solitary hunters because they eat small prey; this means that they lack the supportive resources of a society. To avoid showing weakness, they hide signs of illness very well. The first opportunity we have to improve compliance is to teach people to recognize the subtle signs of sickness. Everyone on the veterinary team also has to recognize that any admission of illness by a cat may signal a problem that has been going on for a longer time than one believes. The following clinical signs are things that clients can be taught to look for through newsletters, the clinic website, Facebook and other social media as well as direct client emails.

**Subtle Signs of Sickness**
(http://www.haveweseenyourcatlately.com/Health_and_Wellness.html)
Clients need to know what to look for and how significant minor changes such as the following can be:

1. **Inappropriate Elimination**: Regardless of how “deliberate” it may seem to be, when a cat is avoiding or not using the litter box, they are trying to tell you something. This message may be of physical discomfort or psychological distress. Physical causes include inflammation of the bladder or bowel, arthritis, hyperthyroidism, diabetes, dementia. Psychological distress may be from social disturbance, boredom, the lack of opportunity to act the repertoire of cat behaviours, anxiety due to other animals, children or adults.

2. **Changes in Interaction**: Changes in how a cat interacts with people, other animals or his/her environment may indicate pain or distress.

3. **Changes in Activity**: A decrease in energy may be abrupt or gradual. The latter is often attributed to “just getting older”, however, as there is no medical reason that a healthy individual should “slow down” due to increasing age, a cause should be sought. Dehydration, pain from anything, including arthritis, hypokalemia ate some of the problems that should be evaluated. The reverse is also true: an increase in energy in a previously normal cat may be an indicator of incipient illness, most notably, hyperthyroidism or hypertension.

4. **Changes in Sleeping Habits**: This refers both to pattern of sleeping (times of the day and night) as well as postures. A cat with pain or with dementia may either sleep for longer or for shorter periods than previously. With FIV infection, the latter may occur. Night-time yowling suggests a decline in vision or hearing, hypertension, hyperthyroidism, pain or dementia.

5. **Changes in Food and Water Consumption**: As with sleep, this refers not just to quantity, but also to changes in behaviours associated with these activities (where, how often, amount at each instance, body posture, etc.).

6. **Unexplained Weight Loss or Gain**: As gratifying as it is to see rapid weight loss in a previously obese patient, even for those on appropriate dietary regimes, it isn’t often a dramatic change. Oral pain may result in inappetence. Gradual weight loss may be related to ageing but should be monitored and investigated. Weight gain is most often from excess calories but could also be due to abdominal or thoracic fluid accumulation. Helpful tools include repeated body weight, body condition score and percentage weight change.
assessments.

7. *Changes in Grooming:* Excessive grooming may be due to a skin irritation (allergy, fleas, dryness), a neuropathy, or psychogenic (as a way to release endorphins and reduce stress). A decrease in grooming is often associated with pain, often arthritic or oro-dental. Hairballs may be a sign of dermatologic, psychogenic, altered digestive motility or pain.

8. *Signs of Stress:* Along with aforementioned inappropriate elimination and overgrooming, signs of distress include hiding, chewing on non-food items, a flicking tail, ear placement further back than normal.

9. *Changes in Vocalization:* Night-time yowling is but one example. Others include a change in tone, pitch, urgency and frequency of vocalizing.

10. *Bad Breath:* Numerous oral and dental conditions result in halitosis: periodontal disease is extremely common in cats but infected ulcers, tumours, sialoadenitis, abscesses and spread through grooming of odour from anal sacs or an infected body region.

Yet, even recognizing that their cat has a problem may not be enough to get the client to bring them in to the veterinarian. Screening to proactively identify disease early and to provide solid medicine can be an even harder sell because people do not like bringing their cats in to the clinic. Many cat owners would rather provide care at home or even skip any form of consultation unless there is something serious going on! This offers us the second significant opportunity to improve the lives of our patients and be of help to our clients.

**Getting Cats to Your Clinic**

It is no fun taking a cat to a veterinary clinic (for the owner or the cat)! All veterinary team members should be trained in teaching clients how to make the trip less stressful, starting at home, while in transit, and once they arrive at the clinic. This conversation begins when the client calls to make an appointment or at the first visit with their cat. The American Association of Feline Practitioners (AAFP) has a free downloadable client handout entitled: *Getting Your Cat to the Veterinarian* (catvets.com/uploads/PDF/2011FelineFriendlyClientHandout.pdf). Clicker training can be used to help create positive associations. Catalyst Council (www.catalystcouncil.org) has created excellent videos that clinic teams and clients can watch to facilitate learning.

The frightening experience begins at home. Imagine the scenario from the cat’s point of view: *The carrier comes out, your caregiver is nervous, she chases you around and tries to force you into the carrier. You resist and may resort to self-defense. There are smells of human sweat, fear, maybe even blood. You may feel so anxious that you soil yourself! Eventually you are in the carrier. Everyone is exhausted. Then you are moved into a “car” that moves without you moving. You may be a bit nauseated; certainly you are scared. You cry out repeatedly. You may vomit or soil yourself. Then the “car” stops and you get carried on a noisy and unfamiliar street and into a place with overwhelming smells and sounds! Help! And you are already aroused and anxious….look out!*

We can reduce the stressors the cat encounters, or, in the case of a new cat, prevent the stressors from occurring by teaching or habituating the cat to associate positive experiences with the carrier, the car, and even the clinic. By leaving the carrier out (or using a Hide Perch Go box/crrier) so that the cat sees it routinely and enters it for treats or other rewards, we dampen
Taking the Household Cat Inventory
While there are a lot of cats who never get taken to the vet, there are a lot of cats living with existing clients we never see. We don’t even know that they exist! If the cat is well or if the client has had a really bad experience in the past with a cat (or anticipates “bad behavior” from a cat), they are unlikely to voluntarily bring them in for preventive care. We need to ask whether they have any cats or any other pets when they bring their dog or cat in for whatever reason will help to identify the un-served patients.

Improving the Clinic Experience
From the client’s point of view: It wasn’t fun to bring her, she isn’t happy about being in the clinic and it isn’t fun watching her be “manhandled”. Once at the clinic, with fear and stress already in place, minimizing or eliminating any further perceptions of threats is extremely important. This requires trying to see the clinic from the point of view of a cat.

IMPROVING A CAT’S CLINIC EXPERIENCES
In many clinics, some veterinarians and other team members do not enjoy working with cats because they may feel anxious about getting hurt. This fear can be reduced by understanding why cats feel that they need to defend themselves, learning to identify the cues, managing the interactions in a positive manner, and making relatively minor changes to what the cat is exposed to.

The basis for working cooperatively with cats is being empathic to their nature and behaviors and trying to imagine what their experience is like. Cats are a species with a social structure unlike ours. We need to look at cats differently and adjust our interactions as well as the physical facility to reduce the strangeness and threats that cats experience in the veterinary clinic.

Making the environment more “feline friendly” can be as simple as having visual barriers in the seating/waiting area to prevent cats from seeing dogs. Covering the carriers with a towel will also help so that cats don’t see each other. If possible, have separate cat-only waiting area. Reserve at least one examination room only for cats to reduce the smells of predators and to be able to furnish it with cat exam and comfort in mind.

Train all staff in respectful cat handling. An excellent and comprehensive resource is the AAFP and International Society of Feline Medicine (ISFM)’s Feline Friendly Handling Guidelines, downloadable at: www.isfm.net/wellcat/UK/FFHG.pdf. It is well worth reviewing and refining cat examination techniques with the goal of making them less threatening. Because value is “perceived worth” and because every visit is a valuable opportunity to educate the client, communicate with the client and the cat throughout the entire procedure. Source and provide feline friendly medications, being sure to follow up one or more times with the client to find out how the patient is doing and if the client needs a refresher course on how to administer the medications. Be sure to send home an exam report with home care instructions for the client to
refer to. Schedule recheck appointments or the next wellness visit before the client leaves the practice.

The AAFP has created the Cat Friendly Practice program through which any interested clinic can raise its cat care IQ. (catfriendlypractice.catvets.com)

WHY CATS RESPOND THE WAY THEY DO
Relying on the “fight or flight” response, cats attempt to escape situations they view as dangerous. From the perspective of a cat, humans are, (and what we do is), dangerous. As a result, we see frightened and defensive cats every day. Cats try to avoid physical confrontation through the use of intimidating sounds and posture. This small creature feels more threatened than we do, so we need to refrain from becoming frightened ourselves. Ideally, they would like to flee. When they can’t they fight (self-defense) or freeze.

Reading and understanding the cues and signals that cats use is important to reducing their fear. It also allows us to respond respectfully. We can learn to avoid using signals that are hostile (e.g., scruffing, making shushing/hissing sounds, looking into their faces).

In the wild, the number of feral cats living together depends on the availability of resources: food, water, privacy and safety, latrine availability, and sexual partners. This results in little competition and a social structure that does not require sharing or taking turns. Stress is minimal unless there is a lack of resources. Aggressive communication signals developed in order to keep distance between individuals and prevent contact with outsiders. Physical injury is to be avoided as a cat must be able to hunt and protect herself. If there are enough resources, the natural grouping consists of a colony of related female cats with their young, who they jointly defend and nurse. Males are relegated to the periphery and vie for the prime breeding spot, only one mature tom usually living with the group.

FELINE SIGNALING: READING THEIR CUES

_Tactile sense_
Touch is very important to cats. They rub against each other (allorubbing), against us, and against inanimate objects. Whether full body rub or a flank, tail, cheek or other body part, this is believed to be an affiliative behavior and is seen between members of the same social group, feline or human. Rubbing is not only tactile, but is also a means of depositing scent. Cats often rub against us; unfortunately, we often misinterpret it as a request to be fed.

Allogrooming (mutual grooming) may precede a playful attack, follow a stressful interaction, and appear to be conciliatory or may simply be grooming. Kneading and treading occurs in adults either as a kitten-regressive behavior or as a component of sexual interaction.

The neck bite/scruffing is a signal that is used in three contexts: transportation young kittens, sexual, and dominating another cat in a fight. Our use of scruffing fits most closely with the last and probably does not belong in a conciliatory, respectful cooperative setting. (See AAFP and ISFM feline-friendly handling guidelines.)
**Olfactory cues**

The role of smell and scent in feline communication is something we human beings are ill-equipped to appreciate. It has been estimated that the size of the olfactory epithelium in cats can be up to 20 cm², whereas people have only 2 to 4 cm² of olfactory epithelium. While olfactory signals may be left by several methods, the one that is most problematic for people is urine spraying. This is a potent communication method that we fail to appreciate. Other forms of olfactory messaging are cheek marking an object or individual, scratching to leave scent from glands below the footpads, and midden, (i.e., leaving a deposit of feces uncovered in a strategic place). All of these have several advantages over visual cues. The message exists over time and in the absence of the sender, allowing for remote communication without the potential for conflict that direct interaction risks. This is especially useful in areas with poor visibility and at night. In this way, these signals help cats spread out over space as well as time-share territory. The disadvantage of this form of communication is that the sender cannot change the message once it has been deposited; it cannot be altered or removed and no adjustments can be made in response to the recipient’s reaction. So, urine marking in the home is an attempt to signal to the other cats when “I was ‘here’” and to establish a routine so that the cats can keep a distance by time-sharing the same space without needing to come into conflict. Every time we remove the urine, we interfere with this communication!

Because of our less developed olfactory sense, we fail to “read” the cues a patient may be giving us and are unable to fathom the overwhelming olfactory messages from previous patients and substances used in the hospital that the clinic experience must present to cats.

**Visual cues: Body language (posture, face, tail)**

Body language and facial expression are extremely effective at maintaining or increasing distance between hostile individuals. This requires an unobstructed view, adequate ambient light, and, unlike olfactory cues, that the two individuals are in the same space together. Body posture gives the big picture of emotional state (see Figure 1), but facial expression (eyes, ears, whiskers, mouth, visibility of teeth) provides the finer details and changes more rapidly. In a clinic setting, for us to appreciate the mental/emotional state of an individual, to avoid provoking them and getting hurt, it is extremely important to watch and interpret facial changes.

As a species that generally leads a solitary existence, survival depends on speed, stealth, self-reliance, and outsmarting others. As a consequence, cats may “bluff,” When they act aggressively, they are generally hiding fear; “stoicism” hides vulnerability; subtle changes in behavior mask significant illness. Body postures communicate confidence and physical prowess that may not be present. Keeping a threat at a distance may eliminate the need for a physical confrontation. The arched back “Halloween cat” typifies this façade of confidence. Making oneself smaller, on the other hand, to minimize threat and evade attention is portrayed by a crouch and withdrawal. In these postures, the weight remains on all four paws so that flight or chase remains possible. A cat feeling less fearful does not need to be on his or her feet. However, an extremely fearful threatened cat will roll exposing his or her abdomen with all four feet ready for self-defense. This cat will also be showing all of its weapons (nails and teeth) and be screaming.
Cats have extremely mobile ears. (See Figure 2.) When the ears are forward, a cat is listening and is generally relaxed or alert but not emotionally aroused. Turned laterally, flat “airplane ears” indicate that the cat is more fearful or feels threatened. When ears are back and tight to the head, the cat is feeling very threatened and frightened. This cat will have a partially or fully open mouth and be hissing, spitting, yowling, or screaming. The cat will protect itself if we fail to reduce the perceived threat level. Ears turned back but erect indicates the most reactive and aggressive state. In this case, the mouth will be closed and the cat will be emitting a low growl with or without swallowing. This is the cat to be apprehensive of.

**Vocalization**
This form of communication requires that the recipient is present; it has the benefit of being easy to adjust from moment to moment. As with other signals, cats have a well-developed repertoire of sounds to convey a need or wish to increase the distance between individuals. The sounds made for encouraging socialization are a trill/chirrup, purr, puffing, prusten, chatter, miaow, and sexual calling. The cat that is open-mouth screaming is highly aroused but is probably less aggressive than the cat that is close-mouthed growl/wah-wah/mowling.

Cats use a combination of these different signals in any situation. We have to learn to look for all of them and interpret them together.

**FROM A CAT’S POINT OF VIEW:**
**Reducing Threats in Your Clinic**
We need to reduce exposure to predators (dogs, people, other cats) and other perceived threats. Looking over our clinic/hospital environment, what can we do to reduce the stress and threat level of the physical and social environment? What things or events assault the five senses of a cat? How can we make positive changes to these? Table 1 shows a chart that can be completed by the clinic team.

**Handling (Examination, Hospitalization, Diagnostics, and Treatments)**
The goal is to handle our patients respectfully and provide an appeasing environment to build positive, long-term relationships. This is achieved by reducing threat and, thus, the cat’s need to react defensively. Avoid doing things in a way that use threatening feline body language or tone. The aggressive cat is upright, stiff-legged, large; sit down to examine him. Never stare a frightened cat in the eyes: examine cats from behind and, other than for ophthalmic evaluation, avoid direct facial viewing. Look at the cat’s face using a sideways glance with hooded eyelids. A slow blink is a reassuring signal to a cat similar to a human smile.

The aggressive cat growls and uses low tones; use light, upper register tones, perhaps chirruping as cats do when they are relaxed with conspecifics. Shushing a cat to try to calm her as we might a child is the equivalent to hissing at her. Short repetitive sounds should be avoided, since these may resemble spitting rhythms. Purrs, chuffing, trills, and chirrups are welcoming sounds.

When cats feel secure and safe, even just able to hide their faces in an elbow or a towel, they allow most procedures. Try to keep all four of their paws on the floor and avoid changing their body position as much as possible. A comprehensive examination, blood and urine collection, body temperature and blood pressure evaluation can all be done without changing the cat’s
position. Examine her in the base of her own carrier if the lid can be removed. Don’t hang a cat’s forelimbs over the edge of a table for jugular venipuncture. For the frightened individual, additional lack of support under the paws is not reassuring.

Reaching into a kennel to pick up a patient blocks the light; to the cat you appear as a looming frightening stranger. Instead approach the opening of a kennel from the side so that some light still enters. Do not block every chance for escape; if the possibility to have some control over her environment and situation exists, she will be much more cooperative. Because cats rely on flight and fight for survival and are not reliant on others, when it comes to restraint, the mantra holds true: *Less is more!* Cats inherently resist intimate handling and restraint. By restraining them, we take away their sense of control and cause them to react. It is very easy to condition negative emotional responses. Scruffing is strongly discouraged as it is an act of dominance that cats may resent. Cat bags, masks, and gloves all carry the scents of similarly terrified patients plus other sundry smells (anal gland secretion, pus, blood, halitosis, etc.) A towel is all that is needed to wrap a cat in, in order to protect the handler. Remember, a cat would rather flee than attack. Similarly, stretching is an inappropriate and unnecessary way to apply restraint.

**Meeting Environmental Needs Improves Health**

Recently, it has been recognized that emotional well-being is highly dependent on meeting the environmental needs of cats. These include those relating to the indoor and outdoor physical environment, as well as a cat’s social interactions, human and otherwise. In the AAFP and ISFM Feline Environmental Needs Guidelines, five pillars are described that form the basis of a healthy feline environment (Ellis, 2013). These pillars are:

1. A safe space
2. Multiple and separated resource stations (food, water, toileting areas, scratching areas, play areas, resting and sleeping areas)
3. Opportunity for play and expression of predatory behaviors
4. Positive, consistent and predictable interactions with humans
5. An environment that respects the importance of a cat’s sense of smell

When these are not met, cats become stressed to varying degrees. Some may express illness (such as inflammatory bowel disease, lower urinary tract inflammation), while others will manifest their distress through inappropriate elimination.

**OTHER CONSIDERATIONS**

As cats age, they tolerate less time in the clinic. Siamese cats are especially prone to becoming depressed. Three days is about as long as a cat can stand the indignities and anxieties of hospitalization, even with daily visits from the owner. Consider capping intravenous catheters and send patients home, having them return for outpatient care. Even for in-hospital care, capping catheters off overnight avoids alarms, which can keep patients awake, and allows greater ease of movement. In either case, administer the overnight fluid volume subcutaneously.

Because cats “see” the world in overlapping clouds of smells, we should strive to provide familiar smells and reduce foreign, medicinal smells. Client-worn shirts or toys from home are helpful in cages. Feline facial pheromone can help to reduce stress. Because cats’ sense of hearing is tuned more finely than ours, a quiet and reassuring environment is desirable. Cats
should not be exposed to the sounds of predators, namely barking dogs. Reducing noises should be addressed when using certain induction agents as some enhance hearing (e.g., ketamine).

Avoid changing a cat’s diet during hospitalization as is likely to result in inappetence and possibly the development of an aversion. If a change in diet is required for therapeutic reasons, try to make that change gradually at home.

Taking a thorough history is especially important given cats’ tendency to hide illness. Listening carefully to clients and their concerns is extremely important. Often clients detect changes that represent real problems. This is probably more common than the client who is blissfully unaware of significant health problems. By asking open-ended questions, we elicit a more detailed history than using only specific questions. For example, asking, “Have you noticed any changes in the contents of the litter box?” will probably evoke a yes or no answer. Asking something like, “What does his stool look like? Initially, followed by: Would you describe it as hard pellets, moist logs, cowpie, or colored water? When did you first notice this?” will probably provide more useful answers. “Is there anything else?” is a very valuable question.

Schedule a recheck appointment to evaluate the effect of any medical or nutritional therapy. Reassessing important variables (e.g., body weight, body condition score, previously abnormal laboratory results) and updating the patient history allows us to provide better care for our feline patients. Care of the client is essential to providing complete patient care. It is only through listening to, educating, and working with the client that we are able to offer the very best veterinary care.

**Examples of Practical Applications**

1. If a cat is uncooperative, a comprehensive physical examination can usually be done using a towel as a protective barrier. Facing the cat away from you is less threatening for her. Confining the cat between your legs as you sit on the floor provides adequate persistent firm restraint that is reassuring rather than frightening.

2. Swaddling a cat’s forelimbs and torso may help with blood and urine collection, placing the cat in lateral recumbency for cystocentesis and making the medial saphenous vein. This vein is also a superb choice for catheter placement and administration of intravenous medications. If the cat is allowed to have her front end in a sternal position while the back end is in lateral recumbency, she may struggle less.

3. Allow the client to be with the kitty as much as, and whenever, possible.

4. Recognize that a persistently elevated systolic value above 170 or 180 mm Hg probably represents true hypertension rather than the stress response. If in doubt, repeat the value later during the visit.

5. Feliway™ (Ceva Animal Health), a synthetic analog of a feline facial pheromone, generally has a calming effect on cats. Spray (or wipe) it into kennels and carriers and even on your clothing before handling an anxious cat. Let the substance evaporate for a few minutes before placing the cat into the sprayed space. Feliway diffusers plugged into treatment and hospitalization areas as well as reception and consultation rooms can help patients relax. (www.feliway.com)

6. Elevated blood glucose and glucosuria may be a result of persistent stress. A diagnosis of diabetes, therefore, should be confirmed by finding an elevated serum fructosamine.
FACILITATING FINANCES
The Bayer study showed that clients want costs spread out over time. Fear of large bills is another significant factor preventing owners from bringing their cats to the clinic. Many practices have wellness plans. Additionally, directing clients toward pet health insurance for both preventive and accident/illness coverage before their cats need it is sound medical advice. This could save lives otherwise lost because the owner hesitated to seek care or decided to euthanize the pet because of financial concerns.

FACILITATING COMPLIANCE AT HOME
Having a library of YouTube links or making your own clinic “how-to” videos is extremely helpful. YouTube videos made by lay people may have the advantage of being more convincing rather than those by healthcare professionals. Find ones that your staff and you as well as a client think are best. There are many good links. Examples of useful illustrative clips to have on hand include how to:
- Give your cat a pill (see below)
- Give subcutaneous fluids: www.youtube.com/watch?v=OLOVw35w4Ns
- Administer insulin: http://www.youtube.com/watch?v=XeZgKLiJn4
- Measure blood glucose: www.veterinarypartner.com/Content.plx?A=605
- Use an inhaler for asthma medications: www.youtube.com/watch?v=INF1W8uaPEA
- Feeding with a feeding tube: contact me at hypurr@aol.com
- Change a KittyKollar (video) and Living with an E-tube (handout): www.kittykollar.com

Syringe feeding, brushing teeth, etc are also available. Cat caregivers like to show their skills and help others.

Similarly, having a selection of web resources that you have vetted and feel comfortable with guides clients to reading materials when they want to learn more about their companion’s medical condition.

Cornell University has a series of videos on a number of procedures and diseases at www.partnersah.vet.cornell.edu. They include: Brushing your cat’s teeth, Giving your cat a pill or capsule, Giving your cat Liquid Medication, Taking your Cat’s Temperature, Trimming your Cat’s Nails. Other free videos include: Caring for your Diabetic Cat, Gastrointestinal Diseases in Cats, Cat Owner’s Guide to Kidney Disease, Managing Destructive Scratching Behaviour in Cats and A Pet Owner’s Guide to Cancer.

Everything on the icatcare website has been created by the ISFM and is excellent: http://icatcare.org/advice/general-care. They have an extensive library of handouts on medical conditions as well as general cat care, including several videos.

Feline Chronic Kidney Disease: www.felinecrf.org

Summary: By not seeing cats because we don’t know they live with clients or because clients are unwilling to bring them in, we lose the opportunity to:
- Provide wellness care,
- Detect disease early when we can prevent or alleviate suffering and save expense.
• Protect life and enhance welfare.
• Build trust with our clients,
• Increase clinic visits.

**TABLE 1. Chart for Evaluating a Clinic’s Perceived Threats to Cats**

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<thead>
<tr>
<th>Sense</th>
<th>Threat</th>
<th>Reduce threat by</th>
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<td>Hearing</td>
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<td>Taste</td>
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<td>Touch</td>
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**RECOMMENDED READING**

1. Buffington CAT. Cat Mastery – e book from iTunes
7. Hide Perch Go and Cat Sense: www.spca.bc.ca/welfare/professional-resources/catsense/
Figure 1. Interpreting a cat’s body posture.

Figure 2. Interpreting a cat’s ear position and facial expression.
Lower urinary tract disorders are common in cats. In previous decades, the focus of study has been on causes and management of crystalluria. As struvite crystalluria was successfully addressed through nutritional changes resulting in urine acidification, the frequency of calcium oxalate crystalluria increased. This encouraged emphasis on urine relative supersaturation (RSS), concentration and a pH neutrality. Nevertheless, cats still present with characteristic lower urinary tract signs (LUTS), namely dysuria, pollakiuria, hematuria, stranguria and periuria. The cause of approximately 65% of non-obstructive lower urinary tract disease is of unknown despite appropriate diagnostic testing. (Possible causes of LUTS are shown in Figure 1. A diagnostic approach to cats with lower urinary tract signs is shown in Figure 2.) These patients are described as having an idiopathic cystitis (IC). It is likely that this syndrome is multifactorial even within the same cat. The course of human interstitial/idiopathic, including interstitial cystitis, is known to be impacted by stress. There is evidence that there are immunological and neuroendocrine components in our feline IC patients as well.

Studying feline idiopathic cystitis (FIC) is extremely challenging not only because of its multifactorial nature, but also because clinical signs are self-limiting. In approximately 91% of cats, evidence of discomfort resolves within 7 days without treatment. Subsequent episodes are also acute in nature and occur once or twice a year. As cats get older, the frequency and severity of the flare-up decreases. A small number of cats experience chronic persistent disease lasting weeks to months.

Inflammation associated with each incident may result in functional or mechanical obstruction. The first may be caused by urethra swelling, spasm, or reflex dyssynergia, while accumulations of inflammatory debris or the formation of matrix plugs can cause mechanical obstruction. Urachal diverticulae are a possible sequelae to FIC.

What causes the inflammation in non-obstructed LUTD? Many studies have attempted to answer this question yet results have been disappointing. Infectious agents, dietary causes (mineral composition, RSS and urine pH), neurogenic, anatomic, traumatic, neoplastic and iatrogenic etiologies are all implicated in some individuals, but the largest category remains idiopathic in origin.

Buffington and colleagues have investigated the problem from another angle asking whether a susceptible individual might develop FIC if they are in a provocative environment. Indeed, similar to the human model of IC, he found that affected cats have structurally altered adrenals, more reactive somatosensory spinal tracts and a larger pontine locus coeruleus (LC, the most important source of norepinephrine in the CNS) This suggests that patients with IC have increased sympathetic nervous system (SNS) activity even during periods without clinical signs. He has reviewed published epidemiologic data regarding the role of environment and its physiologic effects on risk for disease, especially in susceptible individuals. External influences include excessive body condition, decreased activity, being restricted to eliminate in a litter box, being strictly indoors, relocation of home, living with other cats and weather changes. Stressors
(internal/perceived influences) that affect different individuals to a greater or lesser degree include an impoverished environment, lack of stimulation, noise, restraint, and lack of control over his/her environment (including meals). The stress response invokes changes in immune, neurologic and vascular status, all of which can cooperatively result in inflammation. With sufficiently severe stress, sensory input and inflammatory mediators stimulate the hypothalamic-pituitary-adrenal axis (HPAA) and the aforementioned pontine LC – norepinephrine system. With chronic stimulation, over time normal control is lost and affected individuals overreact physiologically to threatening or disruptive situations.

Buffington and co-workers also identified that cats, as humans, with IC frequently have co-morbidities and has called this the Pandora Syndrome. He suggests that the bladder, rather than being the perpetrator of the LUTS, may be a victim of the systemic process associated with the sensitized central stress response system. Comorbid disorders include behavioural, endocrine, dermatological, respiratory, cardiovascular, and gastrointestinal problems. FIC does not necessarily precede the other conditions. In humans, the effects of chronic in utero stress on the health of the offspring are well documented. It may well be that genetic and similar epigenetic events contribute to the susceptibility of an individual making them at risk should they be exposed to provocative events.

**MANAGEMENT OF CATS WITH FIC**
Evaluating the efficacy of therapies for FIC is very difficult because of the waxing-waning nature of the disorder. Stress reduction appears to be a cornerstone for managing cats afflicted with FIC. Addressing environmental needs is essential (not optional) for optimum wellbeing of the cat. Environmental needs include those relating not only to the cat’s physical surroundings (indoors or outdoors; in the home environment or at the veterinary practice) but also those affecting social interaction, including responses to human contact. Cats need to have multiple and separate locations for each resource (food, water, clean litter, toys, stable scratching surfaces, perches and resting areas). The overview of a therapeutic and management approach to a cat with LUTS is shown in Figure 3.

It is essential that cats are able to express their natural behaviours. Cats use olfactory and chemical information to evaluate their surroundings and maximize their sense of security, comfort and feel in control of their surroundings/environment. Depositing pheromones through cheek and paw pad marking as well as urine is key for a cat’s sense of control. In some situations, when a cat is marking with urine, it may be possible to get the cat to make a less offensive mark (from a human perspective). Cheek marking wall corners may be encouraged by using Feliway and not washing the cat’s natural oils off walls and furniture. Likewise, providing secure, stable scratching surface placed in the location being urine marked, may result in the cat scratching and marking in that manner rather than spraying. The **AAFP and ISFM Feline Environmental Needs Guidelines** is an excellent resource freely available from: (jfm.sagepub.com/content/15/3/219.full.pdf+html).

**Pheromone Use**
Feliway™ is a synthetic analog of a feline facial pheromone that is thought to increase emotional stability. Its use in the reduction of inappropriate urination needs to be studied further. Studies done to date have shown a reduction in urine marking of less than three months duration of over 96%. In cats who had been marking for four months or longer, there was a reduction of marking...
in 91% of cats after 35 days of environmental treatment. A third study showed that while there was a significant reduction in all households in which Feliway™ was applied, 2/3 of the households still experienced some marking.

The product is sprayed directly on places soiled by the cat and also any prominent vertical locations in the environment. A daily application is necessary until the cat is noted to exhibit facial rubbing on the site. If the cat does not exhibit facial rubbing, then daily application to the environment should be continued for one month. Plug-in diffusers provide a constant, slow release of pheromone covering an area of 500 to 700 square feet (50-70 m²), but must not be covered, placed behind a door or under furniture.

**Diet and Drugs**

Feeding a diet that produces dilute urine with a neutral pH seems to help cats have fewer recurrences of FIC or any type of lower urinary tract disease. Canned food helps to ensure that the urine is dilute, making it less concentrated (hence, less irritating) and reducing the chance that crystals can form. Having plenty of fresh water available in multiple places in a form the individual cat likes will encourage drinking. Some cats prefer drinking from a recirculating water fountain, others prefer wide bowls. Feeding a diet that has omega-3 fatty acids along with anti-oxidants may also provide beneficial anti-inflammatory effects. Finally, being consistent both in time of feeding as well as diet being fed is very important in reducing stress.

Many drugs have been used to try to reduce the reoccurrence of FIC. Amitriptyline may be helpful in some cats if it is given on an ongoing basis. It is an antidepressant and agent that stabilizes mast cells which may degranulate in some individuals with FIC. Glucosaminoglycans have also been studied and have variable, but generally poor, results. Best results appear to occur with diet, environmental and stress management rather than drug therapy.

**SUMMARY**

Lower urinary tract disorders are common in cats. Once appropriate diagnostics have ruled out direct causes, for most cases of non-obstructive LUTD, a more global approach needs to be taken, looking at and addressing the role of the cat’s external and internal environments.
Figure 1: Possible causes of lower urinary tract signs in cats with or without co-morbid conditions (Pandora Syndrome) (from Chew D, Buffington CAT, FLUTH Symposium 2014)

Figure 2: Diagnostic approach to cats with lower urinary tract signs (from Chew D, Buffington CAT, FLUTH Symposium 2014)
Figure 3: Algorithm showing a therapeutic and management approach to a cat with lower urinary tract disease
REFERENCES AND FURTHER READING

• Buffington CAT. External and internal influences on disease risk in cats. JAVMA, 220 (7): 994-1002, 2002.
• Cameron E, Casey RA, Bradshaw JWS, et al. A study of the environmental and behavioural factors that may be associated with feline idiopathic cystitis. J Sm Anim Pract. 45, 144-147, 2004.
MULTIPLE CATS, MULTIPLE NEEDS
The goal within a multi-cat household is to: 1) determine an appropriate base/common denominator diet available to everyone achieving a feeding strategy that puts no one at risk nutritionally, as well as, 2) to meet any additional individual nutritional needs of each member of the group as closely as possible twice or more times a day “behind closed doors”. This requires analyzing the clowder’s nutritional needs, personalities and physical abilities.

In order to determine what doesn’t put anyone at risk, we need to think about what disease condition is most responsive to or, the reverse, most damaged by feeding the wrong diet. In other words, which cat is most fragile, from a nutritional point of view? Cats are obligate carnivores. This concept is central to understanding the nutritional needs of cats and planning dietary therapies for health disorders, especially when dealing with multiple cats with differing health considerations. We need to review basic nutritional needs of this species before we can decide what modifications can be made safely.

FOOD, FEEDING AND NUTRITION IN A FELINE CONTEXT
Cats diverged from dogs approximately 30 million years ago, evolving metabolically into obligate carnivores with unique strategies for the utilization of protein and amino acids, fats and vitamins. This concept must be at the centre of trying to understand the nutritional needs of cats and planning dietary therapies for health disorders. Domestic cats have not evolved from the wild cat model. They are anatomically and physiologically adapted to eating as many as 10-20 small meals, (a reflection of their hunting behaviour), throughout the day and night. This allows them to hunt and eat when their prey are active. Small rodents make up the majority of their diet, with rabbits, birds, insects, frogs and reptiles making up a smaller proportion. The average mouse provides ~8% of an average feral (i.e. active, unaltered) cat’s requirements. Repeated hunting throughout a 24-hour period is needed to meet this need, resulting in the normal grazing behaviour of domestic cats.

Being obligate carnivores has affected everything about cats: their hunting behaviour; that they eat many small meals a day alone; the small size of their stomach; their lack of salivary amylase; their social structure. Cats are hunters, yet the drive to hunt is independent from the need to eat. Hence, feeding more food doesn’t stop them from killing birds or mice, it merely makes them gain weight. Most cats needs 10-15 attempts to be successful at killing prey, thus the drive to “eye, stalk, pounce and kill” is permanently turned-on to avoid starvation. The average mouse provides 30-35 kcal of energy. Needing 50 kcal/kg ideal weight/day, the 5 kg cat needs 250 kcal or 8 mouse-sized portions/day. These meals are spread out throughout the day, not consumed all at once.

Feeding twice a day or having a bowl that is never empty are not “natural” ways for cats to eat. A 30 kcal meal is approximately 10 pieces of an average maintenance dry food; even eating 10 extra pieces/day results in a 10% (1 lb) weight gain/year. Our need for interaction with our cats
also contributes to obesity. Cats generally interact with us frequently and at a low intensity/casually; people generally want fewer, more intense/focused periods of interaction with them. Eating is not a social activity for cats. We may feel like a bad provider or rejected if our cats don’t eat their food eagerly and seek second helpings. And, because their meals are so small, we misunderstand and want them to eat more. We try different diets until we have “evidence” that they enjoy their food. We train them to ask for food and they train us to respond to their boredom or other unmet needs by feeding them.

Opportunities to express hunting behaviour are a basic need for a cat. If a cat doesn’t have the opportunity to hunt, toys meeting appropriate criteria are small (prey-sized), make high-pitched squeaks or cheeps and move in a rapid, unpredictable fashion. The Indoor Pet Initiative offers an informative piece on choosing the correct toy for an individual cat: http://indoorpet.osu.edu/cats/basicneeds/preypref/index.cfm. Allowing them to hunt for their food (bowl) or using a feeding toy are mentally stimulating activities. Examples of feeding toys include:

Cat Activity Fun Board (www.traininglines.co.uk/cat-activity-fun-board-3397-0.html)
FUNkitty Egg-Cersizer: (www.petsafe.net/search?q=egg-cersizer)
Aikiou Stimulo (www.aikiou.com/stimulo-cat-bowls-and-feeders/)
Catit Design Senses Food Maze (http://usa.hagen.com/Cat/Feeding/Accessories/50745)
NoBowl (www.nobowlcat.com)

Cats are very sensitive to the feel of a food (physical form), its odour and taste. They eat their prey head-first. This is a tactile response to the sensation from the direction of the hair/feathers. Most cats prefer foods that are solid and moist, like flesh, not powdery, sticky or greasy. They prefer their food at fresh-killed body temperature rather than room temperature, out of the refrigerator or hot.

Under stressful situations, cats will refuse a novel food; under other circumstances, the same cat may be very adventurous and chose a new diet over their familiar food. A new diet is more likely to be accepted if it is offered at home rather than in the clinic setting.

Numerous studies have been performed all showing that spaying and neutering/castration decrease energy expenditure by 7-36%. It is, therefore, very important to counsel clients to change from a growth to an adult formulation and to restrict the caloric intake after surgical altering. In general, unaltered cats need 60-80 kcal/kg/day; after altering, they need about 40-50 kcal/kg ideal body weight/day.

While other species can rest their metabolic pathways from the efforts of glucose (energy) synthesis when they have been fed, cats must continue gluconeogenesis in both the fed and fasted states. When anorectic, they catabolize body proteins. Protein supplementation during fasting will slow hepatic lipid accumulation. Urea cycle enzymes in the liver of cats are always „turned on“. Adult cats have a much higher requirement for protein than dogs or humans. Expressed as a percentage of diet, adult cats need 29% vs. the adult canine requirement of 12% or the human need for 8%. Over the long-term, cats can adapt to lower protein diets and use carbohydrates as an alternate energy source. In a paper that is in press (J Fel Med Surg) at time
of writing these notes (Feb 2013), Laflamme has shown that healthy cats need a minimum of 5.2 g protein/kg/day in order to maintain a neutral nitrogen balance.

An elegant study (Hewson-Hughes) has shown that, when cats are able to choose the constituents of their diet, they will aim for a macronutrient profile of 52% protein, 36% fat and 12% carbohydrate. This fits with the many studies of the diets of free-roaming feral cats. In a review of 27 studies, Plantinga showed that the native diet consists of 52% protein, 46% fat and only 2% carbohydrate.

**QUANTITY TO FEED**

50 kcal/kg/day provides a rough guide and refers to ideal body weight. If a cat is overweight, calculate their caloric requirement for maintenance at their ideal weight. This “rule-of-thumb” is adequate for calculations to determine how much a patient should be getting on a daily basis in clinic and as a starting point for the patient when they are discharged. The client should be advised of the actual amount of food to feed when sent home with canned or dry food. Make sure that you are communicating with common vocabulary as what one person thinks of as a “cup” may not be an 8 oz/250ml measuring cup. The most accurate method for measuring food quantities is by using a kitchen scale.

Once feeding any therapeutic diet, it is very important to check and see how the individual patient is responding to the diet by reevaluating them, just as we would recheck a patient on any other medical therapy. Checking body weight and condition cannot be done over the phone. For cats outside of the 2-7kg (5-16lb) range in ideal condition, the 50 kcal/kg/day formula isn’t accurate enough. The following formula is more appropriate: 70 (BW in kg)^0.75 (raised to the 0.75 power). Table 1 provides resting energy requirements (RER) for ideal body weight.

Example: Using this formula (or table) for an 18 lb (8.1 kg) cat:

\[8.1 \times 8.1 \times 8.1 = BW \text{ cubed} = 534.4\]

Press square root button twice on calculator => 23 then => 4.8

\[X \times 70 = 336.\]

Using 50 kcal X 8.1 kg = 405 kcal resulting in overfeeding. Likewise, for a 1kg kitten, the more accurate formula results in 70 kcal vs. the simpler formula, which would under nourish at 50 kcal/day.

Alternately, you can use the nutritional calculator at: http://petnutritionalliance.org/calculator/

**FEEDING FOR LIFE-STAGE OR USING THERAPEUTIC DIETS AS PART OF DISEASE MANAGEMENT**

Let’s apply this overview of very basic nutrition and feline feeding facts to a multi-cat home with multiple nutritional needs to a household consisting of the following twelve individuals:

1. Elderly cat with International Renal Interest Society (IRIS) Stage 3 renal insufficiency
2. Thin, arthritic cat
3. 4 month old healthy kitten
4. 2 year old healthy cat
5. 7 year old obese cat (BCS 8/9, high morphometric measurement)
6. Adult cat with “IBD” who vomits and gets diarrhea readily
7. 10 year old cat with diabetes.
8. 7 year old chronically constipated cat
9. 9 year old cat with CaOx history
10. 2 year old cat with struvite crystalluria
11. Cat with hepatic lipidosis
12. 14 year old hyperthyroid cat

What dietary strategy can accommodate what appears to be completely disparate nutritional needs?

FEEDING CATS WITH RENAL DISEASE

We would like to feed first cat, an elderly individual with Stage 3 renal disease, a protein-restricted diet suitable for renal insufficiency. Do all cats with renal disease have the same etiologic cause for their decline in renal function? Are they all at the same stage? Do they have identical nutritional requirements? Could this cat, perhaps, benefit from being fed a protein enhanced diet, a recuperative diet, a growth diet, a senior diet or a maintenance diet?

Protein: calorie malnutrition occurs when a cat is getting enough calories but not enough of them come from protein. As a result, there may or may not be weight loss, but there will be muscle wasting as well as a deterioration in the hair coat quality. Because protein is component in antibodies, immune function may be compromised; anemia may be exacerbated due to the lack of building components for hemoglobin; albumin levels may decrease and tissue healing may be affected. Protein is a preferred flavour, so if a cat is already inappetant, restricting protein may result in inadequate intake of all nutrients, and the protein intake may fall below that required for normal function.

As an obligate carnivore, if a cat doesn’t get enough dietary protein to meet metabolic requirements, he must draw on endogenous, stored protein sources to meet those needs. Over months, cats can down-regulate their protein needs and switch to use other pathways, but in the short and intermediate term, muscle will be catabolized. The resulting muscle wasting and decreased mass reduces the serum level of creatinine (Cr) measured. This makes it difficult to know how much of a Cr decrease seen in a cat fed a restricted protein diet is from improvement in renal function and how much is because there is less functional muscle producing Cr.

Despite numerous experimental studies and clinical trials, questions about feeding protein to the cat with renal disease still remain, including:
1. What is optimal amount of protein for a cat with CKD? How much restriction is necessary?
2. Do different types of kidney disease require different dietary therapies?
3. At what point in disease progression should protein restriction be implemented?
4. Does the type of protein fed make a difference?
5. Does every meal have to be restricted?
6. Is phosphorus restriction as, or more, beneficial than protein restriction in Stages 2 and 3?
7. Might some cats with advanced disease benefit from increased protein levels?
8. Should the diets of cats with proteinuria be protein restricted or enhanced?
Protein levels in “restricted” and “high” protein diets fall within the nutritional guidelines, merely at the low or at the high end of the range. Protein-restricted therapeutic diets are not all the same; there are some marked differences in their composition, not just in protein sources and quantities, but also in the calorie source, in phosphorus, potassium, and sodium content.

Dietary protein is not, in and unto itself, toxic to kidneys. Because of inherent progression of chronic renal insufficiency, IRIS staging focuses on factors which, when managed, are known to slow progression. These are: azotemia, metabolic acidosis, hyperphosphatemia, proteinuria and hypertension.

Azotemia, metabolic acidosis and, to some degree, hyperphosphatemia are affected by hydration, thus optimizing hydration through the use of canned diets, adding water to food, encouraging drinking by use of flavoured liquids or a fountain along with the use of daily subcutaneous fluids are beneficial to the well-being of the patient. The patient should enjoy the diet offered, regardless of what illness he/she has. *It is always more important that they eat, rather than what they eat.* And the *amount consumed must be monitored.* This requires calculating the caloric requirements for each individual. 50 kcal/kg/day is a reasonable goal. By being made aware of how much food this is equivalent to, they can notify the veterinarian should the cat be eating less than that amount. This helps prevent confusion regarding weight loss associated with progressing disease vs. that associated with inadequate nutrient intake.

Returning to the cat in question, we do not know from the description (Stage 3 chronic kidney disease) whether the cat is proteinuric or not, nor what the phosphorus or potassium levels are. A protein-restricted diet (which one?) may be appropriate, but one of the other aforementioned diet types (protein enhanced, recuperative, growth, senior or maintenance) might be the correct diet for this individual. Just because someone has a specific illness does not automatically mean that the diet designed for that *condition* is the best diet for that *individual*.

Every time we send home a therapeutic diet, we are performing a feeding trial with one subject in it (n=1). We have to get the cat back into the clinic and see how he/she is doing on that food. How is his weight? Increased? Decreased? How is his coat? Does he eat with enjoyment or vigour? What are his stools like (moist logs or dry pellets, cow patties or coloured water)? How energetic is he since he has been on this diet? Has there been a change in his PCV and proteins? In this case, have the BUN and Cr, the phosphorus and calcium or usg changed? Is he proteinuric and potentially protein deficient? What about his blood pressure? Have these parameters increased or decreased?

**Feeding for arthritis**
What are the nutritional requirements for cat #2 who is thin and arthritic? Options include a mobility/joint die or, for weight gain, a kitten diet, a recuperative diet, or possibly a senior diet. Assuming that the physical examination and diagnostics do not reveal a cause for her weight loss, it is reasonable to try a variety of diets including all of above in case she has become bored with her food. The addition of omega-3 fatty acids appears to be beneficial as does supplementation with green-lipped mussel extract and glucosamine/chondroitin sulfate.
**Feeding growing cats and elderly cats**

Young cats have growth requirements, which include an increased proportion of animal based protein and more calcium and phosphorus. The 4-month old kitten (#3) and the 2-year old healthy adult (#4) would ideally be fed a kitten diet and a maintenance diet respectively. Elderly cats over 12 years of age have been shown to have an increased need for protein, relative to adult cats. They also need more calories from fat than during their adult stage. In part this is because of a decreased ability to digest and absorb fat and protein.

**Feeding obese cats**

For the fifth cat, the 7-year old obese kitty with body condition score (BCS) 8/9 (or 4.5/5) the therapeutic strategies may include a high fiber diet, a high protein, low carbohydrate balanced diet, or a low fat diet. Exceeding a cat’s protein needs beyond maintenance requirements helps induce satiety. In a study by Laflamme et al, when cats were fed a diet with 45% of calories from protein, cats lost more fat and less lean mass compared with cats fed a diet with 35% of calories from protein, despite similar total weight loss and rate of weight loss.

Traditional belief holds that it is the calories ingested versus expended that is required for weight loss and that it doesn’t matter which approach we choose, (making this cat very flexible) as long as the caloric intake is reduced, the diet is balanced, the cat isn’t feeling deprived and pestering the client and the diet is balanced. Given the benefits of achieving lean body mass by feeding a high protein diet, a goal of at least 40% protein, dry basis, in a low-fat diet (6% to 10% fat) is a healthy approach to take. Feeding closer a native, paleolithic high protein, lower carbohydrate diet may have hormonal benefits that favour lean, however this idea has not been proven.

**The KEY is in determining how much the cat should weigh.**

The thermic effect of food (TEF) refers to the energy cost of digesting and absorbing food. TEF is higher when meals are small and frequent, so feeding multiple small meals is preferable to feeding one or two large meals. One way to incorporate this into the diet—and give the cat a little challenge (and exercise)—is to divide the day’s food into six or seven small portions, using feeding balls or placing it on saucers throughout the home as if the cat were on a “treasure hunt”. This feeding strategy makes the cat less likely to gorge and entices him or her to look for more, all of which has a higher TEF cost.

Calculating the quantity of dry and/or canned food to prescribe for weight loss:
1. Determine or approximate the cat’s **ideal** body weight in kg
2. Calculate the number of calories needed to maintain that ideal weight (wt in kg X 50 kcal/kg/day)
3. Multiply this number by 60-70% to get the amount of calories to feed for weight loss.

Include the calories in the treats and supplements, people food and pill pockets that the kitty is being given when you figure out the quantity of food to recommend. As with the protein-restricted diets, the composition of therapeutic diets designed for weight loss are very different from each other.
Feeding cats with intestinal sensitivity
Our dietary choices for cat #6, the adult with the sensitive gastrointestinal tract and a diagnosis of “IBD” are either a limited antigen, a “hypoallergenic” or a hydrolyzed protein diet. Some cats may tolerate a highly digestible, low residue intestinal diet.

Feeding cats with diabetes
Cat #7 is the 10-year old diabetic. Feeding strategies include a high protein, low carbohydrate diet or a high fiber diet. However, a diabetic cat can be controlled with insulin as long as the diet and treats fed remain consistent from day to day.

Neither carbohydrates nor dry extruded diets are cause of diabetes or obesity. However, exchanging dietary carbohydrate for protein appears to be useful for weight loss treatment and management of non-insulin dependent diabetes in cats.

In a prospective, randomized, double blinded 10-week study (Hall et al), 12 cats (7/12 obese) of whom six were newly diagnosed and six were poorly controlled diabetics evaluated standard maintenance diet vs. lower carbohydrate, higher protein (LCHP) diets. The cats ate dry or canned based on their preference. All were treated with glargine and assessed at weeks 1, 2, 4, 6, and 10 with fructosamine, BG curve and clinical signs. One cat from each diet group achieved remission by week 10. All cats improved clinically, increased weight and achieved good glycemic control. Those fed the LCHP had a significantly greater decrease in fructosamine. The conclusion, based on this small study was that using insulin, “frequent monitoring is key to achieving glycemic control in diabetic cats; potential benefits of dietary modification require further evaluation”. The author summarizes all of the preceding studies and approaches: high fiber & low fat, high insoluble fiber vs. low fiber, LCHP canned, low carbohydrate diet vs. low carbohydrate & low fiber diet vs. moderate carbohydrate & high fiber diet. None of these approaches appears to make a meaningful difference in the small numbers of cats in each study.

Feeding the constipated cat
Constipation is, first and foremost, treated through rehydration. As long as cellular dehydration is present, the need will exist to resorb water from renal and gastrointestinal systems. Addition of fiber to the diet should be avoided until the patient is adequately hydrated. Use of enemas, promotility agents and laxatives prior to addressing this underlying problem is ineffective at best and has the potential for exacerbating the problem. Once that has been accomplished (or simultaneously to rehydration), once can focus on assisting the passage of the feces by mechanical or pharmacologic means.

Soluble fibers are helpful in diarrhea; insoluble fibers are beneficial for constipation. Dietary fiber is a combination of soluble and insoluble fibers. Recently a dry diet enhanced with psyllium has been marketed for the treatment of constipation. Along with rehydration, feeding this diet alleviated obstipation in cats with megacolon allowed them to cease medication, avoid surgery or euthanasia. Another approach is to reduce fiber feeding a low residue diet.

Feeding cats with lower urinary tract disease
Ensuring that urine is in a neutral pH and stays dilute enough so that mineral components don’t
come out of solution (i.e., urine remains undersaturated) will help reduce the chance of either CaOx or struvite crystals from forming.

**Feeding for hepatic lipidosis**
The most important thing is that the cat gets adequate calories without restricting protein. Lipidosis is a disorder of lipoprotein metabolism. Additionally, L-carnitine, S-adenosylmethionine, B vitamins and taurine may be supplemented. If the cat has an esophagostomy tube in place, ensuring nutrition is easy if kitty isn’t eating enough on his/her own.

**Feeding for hyperthyroidism**
Use of the extremely low iodine-containing diet in a multi-cat household such as this is inappropriate.

NOTE: For all cats in the household:
Make sure that water, the most important nutrient, is readily accessible. Have lots of water stations around the home. They should be in places other than the “kitchen” as well, so that cats don’t have to compete and because cats like to eat and drink in different places.

**Baseline diet**
The first of the two goals for feeding a multi-cat household is to achieve a feeding strategy that puts no one at risk nutritionally having the base/common ground diet available to everyone. Of these twelve cats, the one at greatest risk if fed the wrong diet is the cat with “IBD”. If the cat with renal disease were in IRIS stage 4, he may well be the most delicate, but just getting adequate calories into a uremic cat becomes the main concern at that point and placing a feeding tube would allow us to deliver an appropriate diet. We would also have to think about a different strategy for restricting access to other diets if he were feeling well enough to be roaming the house. If he is hyperphosphatemic as well as being in stage 3, using intestinal phosphate binders is a viable and necessary alternative to using a restricted protein diet as the baseline, everyone eats, diet. (He can still get the restricted protein diet twice a day.)

**Supplementing requirements**
The second goal is to meet the individual nutritional needs of each member of the household as closely as possible twice a day “behind closed doors”. Certainly the “IBD”-safe diet can be left out during the day for all cats to eat. Twice daily all cats other than the cat with gastrointestinal disease, can be placed in separate rooms to be supplemented with their different or additional needs. This requires analysis of the clowder’s needs as well as their personalities and physical abilities. The elderly cat who is less able to jump can be prevented from eating the food of an agile youngster if the growth diet is placed high up. An overweight cat can be prevented from getting to any food other than that designed for weight loss (the base diet) by putting a latch on a door, building a creep feeder or using a “keyed” cat flap (such as one that responds to the cats’ pre-existing microchips: www.sureflap.ca) so only the thinner cats can get through the narrower space. Treasure hunts using small quantities of food as well as feeding balls (which some cats won’t want to us) will also help. Figuring out creative strategies to use based on the strengths and weaknesses of the individuals is an intriguing challenge and needs to take the cats’ physical, personality and nutritional profiles into consideration.
Reducing stress in the multi-cat household must always be a focus. Cats are social but with strict social rules and restrictions to keep distance in order to avoid confrontation. Recognizing the environmental needs is extremely important. Ellis writes eloquently about this. http://www.catvets.com/guidelines/practice-guidelines/environmental-needs-guidelines.

**Key points**
1) Don’t assume that a diet designed for a particular clinical condition is necessarily the best diet for every cat with that condition.
2) The quantities to be fed listed in product guidelines are a starting point. Each cat is different.
3) Monitor the clinical response of the individual patient to the dietary *prescription*.

<table>
<thead>
<tr>
<th>Cat Body weight (lbs)</th>
<th>Body weight (kg)</th>
<th>RER*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.45</td>
<td>39</td>
</tr>
<tr>
<td>2</td>
<td>0.91</td>
<td>65</td>
</tr>
<tr>
<td>3</td>
<td>1.36</td>
<td>88</td>
</tr>
<tr>
<td>4</td>
<td>1.82</td>
<td>110</td>
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<tr>
<td>5</td>
<td>2.27</td>
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<tr>
<td>6</td>
<td>2.73</td>
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<tr>
<td>7</td>
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<td>8</td>
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<td>9</td>
<td>4.09</td>
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<td>10</td>
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<td>218</td>
</tr>
<tr>
<td>15</td>
<td>6.82</td>
<td>295</td>
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<tr>
<td>20</td>
<td>9.09</td>
<td>366</td>
</tr>
<tr>
<td>25</td>
<td>11.36</td>
<td>433</td>
</tr>
</tbody>
</table>

RER = \([\text{BW(kg)}^{0.75} \times 70]\)

Growth DER (Kcal/day): Growing kittens = 2.5 X RER

**Maintenance DER (Kcal/day):**
- Normal, neutered adult = 1.2 X RER
- Intact adult = 1.4 X RER
- Obese prone = 1.0 X RER
- For weight loss = 0.8 X RER

RER- Resting Energy Requirement: the energy required for a normal individual at rest in a thermoneutral environment based on body weight.

DER – Daily Energy Requirement: the average daily energy expenditure of an animal dependent on lifestage and activity (work, lactation, gestation, growth).
REFERENCES:

### Table 2: FELINE REDUCED PROTEIN AND PHOSPHORUS DIETS
Listed in order of decreasing protein content – all non-acidifying Nutrients of Concern (/100 kcal)

<table>
<thead>
<tr>
<th>Product</th>
<th>kcals/can or cup</th>
<th>Protein (g)</th>
<th>PO4 (mg)</th>
<th>Na (mg)</th>
<th>K (mg)</th>
<th>Fat (g)</th>
</tr>
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<tbody>
<tr>
<td>Hill's j/d (5.5 oz can)</td>
<td>152</td>
<td>9.3</td>
<td>195</td>
<td>102</td>
<td>205</td>
<td>4.6</td>
</tr>
<tr>
<td>Hill's j/d (dry)</td>
<td>506</td>
<td>8.6</td>
<td>161</td>
<td>79</td>
<td>198</td>
<td>5.3</td>
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<tr>
<td>Science Mature Hairball (dry)</td>
<td>326</td>
<td>8.5</td>
<td>182</td>
<td>101</td>
<td>211</td>
<td>5.0</td>
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<tr>
<td>Hill's y/d (dry)</td>
<td>519</td>
<td>8.2</td>
<td>150</td>
<td>58</td>
<td>188</td>
<td>5.8</td>
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<tr>
<td>Hill's y/d (5.5 oz can)</td>
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<td>8.2</td>
<td>141</td>
<td>58</td>
<td>207</td>
<td>6.2</td>
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<tr>
<td>Hill's g/d (5.5 oz can)</td>
<td>165</td>
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<td>123</td>
<td>76</td>
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<td>135</td>
<td>72</td>
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<td>Purina NF (5.5 oz can)</td>
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<td>110</td>
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<td>180</td>
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<td>50</td>
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<td>3.0</td>
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<tr>
<td>Iams renal plus (dry)</td>
<td>514</td>
<td>7.1</td>
<td>93</td>
<td>87</td>
<td>142</td>
<td>5.7</td>
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<tr>
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<td>65</td>
<td>216</td>
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<tr>
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<td>6.8</td>
<td>128</td>
<td>82</td>
<td>217</td>
<td>5.8</td>
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<tr>
<td>Hill's l/d (5.5 oz can)</td>
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<td>6.7</td>
<td>145</td>
<td>43</td>
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<td>4.9</td>
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<td>Hill's k/d (dry)</td>
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<td>56</td>
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<td>Hill's k/d chicken (5.5 oz can)</td>
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<td>85</td>
<td>68</td>
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<tr>
<td>Royal Canin hepatic (dry)</td>
<td>439</td>
<td>6.3</td>
<td>150</td>
<td>80</td>
<td>200</td>
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<tr>
<td>Royal Canin renal LP modified-P(pork) (dry)</td>
<td>428</td>
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<tr>
<td>Royal Canin hypoallergenic hydrolyzed HP (dry)</td>
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<tr>
<td>Royal Canin renal LP Modified-C (chicken) (dry)</td>
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<td>Royal Canin renal LP modified (6 oz can)</td>
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<td><strong>AAFCO minimum</strong></td>
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<td><strong>50</strong></td>
<td><strong>150</strong></td>
<td><strong>2.3</strong></td>
</tr>
</tbody>
</table>

As of December 2012

Note: manufacturers change diet compositions from time to time and diets differ in different parts of the world.