What we may consider “advanced anesthesia techniques” may vary from institution to institution. These notes will cover what can be expected as atypical in most situations. A strong understanding of basic anesthesia techniques and monitoring should be had or someone who is familiar with the techniques and methods before jumping to any of the techniques discussed.

**Pre-Anesthetic Preparedness:**
Being prepared is essential for a successful procedure, not to mention hastening induction, anesthetic time and recovery. Everything one will and might need should be at hand or setup prior. Cheat sheets of emergency drugs should be made and, although a bit wasteful, pre drawn in the event of an emergency.

**Intubation and Airway Protection:** Typical intubation via a correct size cuffed or uncuffed tubes ETT may not be feasible for certain emergency cases or protocols. Knowing what other options are available are key for advanced level care. The first technique that can be used in more emergent or very difficult to intubate patients is the retro ventral approach. This method utilizes a large gage hypodermic needle placed ventrally into the trachea allowing a cerclage wire or rigid fishing line to be passed through the needle rostral. The wire is then used like a stylet to pass an ETT over. Once the tube is placed the needle and wire are removed.

The next option limited to certain species such as rabbits, cats and now dogs at this time are laryngeal mask airways (LMA). These specialized tubes have been used in human medicine for years. The tube has a modified distal tip that cups the supraglottic region to maintain an airway, not entering the trachea. One company exists that makes veterinary LMA’s for rabbits, cats and now dogs. Variable anatomy and size selection are two critical points in the use of LMA’s. Mechanical ventilation can be more challenging. For avian species utilizing an air sac rather than the trachea is also possible. While this method is surgical it does provide an excellent option of a oral or cranial procedure is to be performed. Anesthetic gas and O2 may need to be turned up from escaped gasses through the mouth.
Lastly is a tracheostomy. This is the most invasive of airway management. There is a great deal of care and maintenance in animals when utilizing this method. An incision is made trough the ventral neck soft tissues and into the trachea where a stoma is created to insert a ETT or Trach tube. Animals that will have long term tracheostomy tubes may need a snorkel created to prevent occlusion of their airway while sleeping.

**Capnography:** Although capnographs are becoming more and more standard on multiparameter monitors correct or accurately interpreting of the waveforms is still fairly low in veterinary medicine. Typically the waveforms are looked upon as just breaths. However each wave is indicative of a breath or lack thereof, there is so much more that can be gathered from the wave stature and anatomy. Understanding the waveforms better will allow anesthetists to gage the quality of the breath, possible occlusions or leaks and perfusion quality of the animal.

**Local Anesthetics and Epidurals:**
The use of local anesthetics is not extremely advanced, but is often underutilized. In any species of mammals, avian, reptile or amphibians literature suggests the use of local anesthetics to reduce doses of systemic anesthesia, bettering the physiological parameters we monitor and strive to keep with normal limits. The general rule of thumb for dosing in all taxonomies is 2mg/kg of lidocaine or bupivacaine. If more volume is needed the local anesthetic can be mixed with 0.9% saline with minimal change to the efficacy of the block. Anatomy seems to be the biggest hindering factor for exotics as far as common blocking techniques such as brachial plexus, paravertebral or femoral blocks.
Epidurals can theoretically be performed in any species with epidural space, which is all vertebrates. Although species specific dosing of epidural medications is still largely extrapolated from small animal dosages, opioid epidurals are typically safe for most species and should be considered.

Venous/Arterial Access: (Arterial, venous, IO, Central lines, sheaths)
Intravenous catheterization in exotics can prove challenging, but may be crucial to the animal especially if a blood transfusion is warranted. The option of accessing ear veins is available in species such as rabbits and mini pigs. Take heed there is a potential for ear sloughing in rabbits if certain medications leak perivascularly. Rats and mice can be catheterized via the lateral tail veins. Special micro catheters commonly used in the lab animal setting may be a worthwhile investment if your practice anticipates exotic pets, be it on a regular basis or intermittently. Some exotic pets such as mini pigs, small primates, and the occasional rabbit can tolerate femoral catheterization; however, this method is less ideal for continuous use post procedure where the animal is expected to be ambulatory. *Arterial femoral access using a 22 gage catheter is ideal for invasive blood pressure monitoring.

Bats, although not a common nor generally legally kept exotic animal to own, have accessible wing veins. It is better to stay with vessels in the hind limbs before using the wing approach as they can have similar sloughing effects seen with rabbit ears.

The vascular anatomy in a bird can make blood pressure monitoring and catheter placement more interesting compared to our mammal patients. Depending on the size of the bird an IV catheter can be placed in the right jugular vein, basilic vein or medial metatarsal vein. In smaller birds, one may find it easier to place an IO (intra-osseous) catheter. Anatomic sites used for IO catheter placement include the distal ulna (larger birds), lateral femur (young and small birds), proximal ulna and proximal tibiotarsus bone. Reptilian IV catheterization poses a more difficult challenge. Often IV access in reptiles will require a cut down. In large species tail veins are accessible percutaneously. In Chelonians jugular access is readily available after light sedation. For amphibians, taking advantage of their ability to soak up fluid and absorb chemicals through their skin should be taken advantage of. Intraosseous methods are well described in many small exotics and are fairly easy to place. Intraosseous catheterization using a spinal needle, IV catheter stylette or regular hypodermic needle can be used for this method. A sterile piece of cerclage wire may be needed to clear our boney material. *Appropriate local anesthetics, sedation and proper management should all be well thought out if IO catheterization is utilized.

Induction Methods: We are all familiar with mask/chamber induction, propofol and Ket/Val induction, but what else is there? Tailoring anesthetic medications based on the patient health status can alleviate induction related complications intra-operatively. Other benefits of tailored induction protocols, depending on the half-life of the medications used, can compliment analgesic protocols and have MAC sparing effects.

TIVA and CRI’s: Gas anesthesia is not ideal for some protocols or situations therefore we are left with IM sedation with more difficult titration depending on the surgical intervention and stimulation, patient pain levels and emergent situations. To ease the less than ideal complications surrounding general sedation using IM medications, total intravenous anesthesia (TIVA) via the venous system should be utilized. TIVA offers the anesthetist the option of titration, emergency analgesia and the ability for multimodal anesthesia. There are numerous protocols that can be used for different species. The author prefers these various mixtures because of their cross species safety and efficacy: Fentanyl/Midazolam/Lidocaine/Propofol or Alfaxan

Lung Recruitment is a strategy aimed at re-expanding collapsed lung tissue, and then maintaining high PEEP levels to prevent subsequent ’de-recruitment’. In order to recruit collapsed lung tissue, sufficient and even scary pressure must be imposed to exceed the critical opening pressure of the affected lung. In dependent areas of the lung, the pressures required may exceed 50cm H2O in
human lung recruitment procedures. Such pressures dangerous for upper lung lobes and alveoli increasing risk for trauma. A strategy is needed to limit trans-alveolar pressures in the upper lobes, and provide sustained high pressures in the lower areas of the lungs sufficient to cause recruitment of collapsed tissue, most commonly achieved with special positioning. (This technique should not be done without appropriate training and research)

**Percutaneous transtracheal ventilation** is a method of placing a large gage needle directly into the trachea to provide emergent or supplemental oxygen to the lungs. The needle placement is generally midline just under the thyroid cartilage and above the cricoid cartilage. This is a temporary maneuver and should only be performed on anesthetized or sedated patients as risk of injuring the tracheal or esophagus and even major vessels increases with movement.

**Monitoring:**
Anesthesia monitoring for exotics greatly echoes cat and dog anesthesia. Special monitoring equipment used in the research setting can better accommodate higher heart rates seen with smaller mammals and offer more reliable ECG tracings. Pediatric settings should be utilized on all monitors if conventional monitoring equipment is used. Laboratory animal vendors also offer miniaturized anesthetic machines, eliminating dead space that we see in regular sized anesthetic machines. Micro ventilators are also available, which are specially designed for patients in the 150-400 gram weight range. If you find yourself spending more time setting up a patient with every bell and whistle, prolonging anesthetic time, it may be more advantageous to simply finish the procedure without every monitoring gadget attached and go back to basics. Being able to use ones stethoscope, eyes, ears, touch and intuition are just as vital as any piece of monitoring machine.

Appropriate and inappropriate gas exchange in special species has the same positive and detrimental effects as it does in dogs and cats, but resiliency to hypercarbia can be less appreciable in mammals and birds. Reptiles and amphibians can tolerate anoxic conditions better by being able to switch to an anaerobic metabolism.

*In diving species of birds, reptiles and mammals, gas exchange can prove challenging without mechanical ventilation and appropriate anesthetic depth.*

Because the surface area to body mass is high in many small exotic patients, maintaining a normal body temperature is challenging, yet critical. The cooling effects from surgical scrubbing will add to this challenge. Normothermia will help retain a steady metabolic rate and aid in keeping a normal blood pressure to perfuse our patients’ vital organs.

With tiny or anatomically challenging species, like a hedgehog or hummingbird, intubation and blood pressure monitoring may not be as feasible for all of our patients. This makes it even more crucial to maintain the optimal temp for a particular species. Using warming devices such as warmed surgical tables and circulating warm water blankets work well. *Caution should be taken to not allow direct contact with the patient, in order to avoid thermal burns.*

Recently warm water bags have been shown to have an opposite effect and can steal heat from an anesthetized patient as they cool. Warm air blowers are ideal, but can be cumbersome with such tiny patients. A personal favorite is bubble wrap. Not only is it cheap and disposable, it also offers a lightweight and insulated option in thermoregulation. Tiny knitted socks work well to cover exposed limbs. Humidivents™ are also a good option, but can add to dead space and IPPV may be indicated. These devices work by inserting the device between the ETT and the circuit hose. The paper filter keeps warm moist air in the chest cavity. They also help protect the anesthesia machine from aerosolized bacteria the patient may be harboring with expiration. As a last resort, warm water enemas can be used in extremely cold patients, but a cooling evaporation effect can occur if the patient becomes wet during
the process. *A rabbits ears comprise around 12% of the animals’ surface area and a bats wings comprise about 85% total body surface area and can be used to cool quickly or warm a patient. Cardiovascular and blood pressure management also greatly resonates the methods used in small animals. A staple in avian, reptilian and amphibian anesthetic monitoring is the ultrasonic Doppler. The crystal can be placed in multiple different sites and also gives an audible indicator as to the pulse rate and quality. Most commonly the crystal is placed on the radial artery or tibiotarsus artery is birds. Here a blood pressure cuff can also be placed proximally to the crystal for non-invasive blood pressure monitoring. Other sites include the jugular vein and palatine artery of the dorsal bill. Placing the crystal over the heart in reptiles and amphibians is the most common site. In larger species ventral placement on the tail or an very well lubricated eyes is efficacious.

Arterial blood pressure monitoring is the gold standard in any species. In medium to larger sized birds, placement of the arterial catheter at the brachial or carotid arteries has been performed. Having IV access is crucial in supportive cardiovascular support either by medication or appropriate crystalloid or colloid infusion. Constant rate infusions of dopamine, dobutamine, ephedrine, caffeine, norepinephrine or phenylephrine can be used after volatile gasses are titrated down or after the start of a multimodal anesthesia protocol with MAC reducing CRI's of analgesics or other anesthetic agents for blood pressure management. The animals’ temperature should be normal and other contributing factors addressed before moving to BP supporting medications that can cause tachycardia among other arrhythmias. Most small mammals have a quick metabolism requiring a high caloric intake to keep glucose levels in normal range. Even short fasting preoperatively in combination with possible poor appetite due to the patients underlying condition even more greatly affects a patients glucose levels. Although current fluid therapy is leaning away from the addition of dextrose in fluids, it still may be necessary if the patient has been anorexic prior to the anesthetic event, is aged or a neonate. Using a balanced crystalloid fluid made to 2.5-5% dextrose solution is recommended and can even be given SQ in the worst case scenario. Having quick recoveries with a normal temperature will only better your patient’s odds by regaining caloric intake as soon as possible. Remember an ill or recovering patient has a greater demand for caloric intake than a stable healthy animal. In many exotic species fasting is not advised or limited to only a 3-6 hour fast prior to the anesthetic event. Fortunately many of these same patients are unable to vomit (mice, rats, rabbits, squirrels, beavers, guinea pigs), reducing chances of aspiration. Ferrets and shrews do have the ability to vomit and in these species the limited fast may be indicated. Antiemetic drugs are available and are relatively safe. Some new anti nausea medication such at maropitant do have MAC sparing effects.

References available upon request