

ANESTHESIA FOR EXOTIC SPECIES

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Introduction

- Although there are wide variety of exotic species this lecture will primarily cover aspects related to anesthetizing birds, small mammals, reptiles and fish
- In a survey carried out by the Association of Veterinary Anaesthetists (AVA), rodents and other small mammals had much higher clinical mortality associated with anesthesia (**1 in 32**) than in other domestic species (e.g. 1 in 1,000 for dogs). The cause of such high mortality probably results from **unfamiliarity** with the species and the generally less healthy state of the animals
- There has been a growing popularity of exotic pet ownership in recent years, and as a result, more practitioners are faced with dealing with exotic species
- Many exotic species become easily distressed to handling, increasing the risk of physical damage and of epinephrine release leading to development of complications under subsequent anesthesia
- Proper preanesthetic examination of exotic species is often difficult and exact body weight and health status are difficult to pre-determine.
- Previous status of nutrition, parasite load, pregnancy and other underlying disease are major anesthetic consideration but are also difficult to pre-determine
- Many animals presented to the practitioners have respiratory disease so oxygen availability is important even if only injectable anesthetics are to be used
- As a general rule, the principles of anesthesia as applied to domesticated animals should apply equally well in all these animals and the main differences arise from the need to protect the anesthetist and any assistants from injury by unanesthetized subjects.

Avian anesthesia

Physioanatomic peculiarities

- Birds have air sacs (up to nine) acting as bellows to the lungs but these are not involved in gas exchange
- In a tracheal obstruction, cannulation of caudal thoracic air sacs can still provide ventilation
- Larger anatomic dead space for ventilation, but much higher surface to volume ratio along with thinner blood-air barrier, making the gas exchanges much more efficient
- A greater percentage of oxygen is extracted from inspired air than mammals because of highly efficient crosscurrent flow of air and blood, and continuous gas exchange along the parabronchi
- The trachea is composed of complete cartilaginous rings
- Respiratory muscles are used both for inspiration and expiration
- Vocal folds, arytenoids, thyroid cartilages, and epiglottis are absent
- There is no diaphragm separating thoracic and abdominal cavities, and the thoracic space is at atmospheric pressure
- Syrinx is found near the bifurcation of the trachea

- Lungs are less elastic, and have smaller functional residual capacity
- High basal metabolic rate results in rapid utilization of any tissue oxygen reserve
- Renal portal circulation may reduce the efficacy of anesthetic drugs when injected in the leg muscles or veins. However, this is of little clinical significance as one can increase the anesthetic dose until the desired effect is achieved

Preparation for anesthesia

- Thorough physical exam and history taking must be carried out: if non-approachable, behavioral characteristics are assessed in distance
- They are very liable to develop handling stress so observation may be the only practical pre-anesthetic evaluation process. Any changes in body disposition, feather condition, grooming should be carefully assessed.
- They can be brought into the pre-induction/procedure areas in advance to acclimatize so as to reduce the stress
- The following laboratory data are generally required as minimum: PCV, TP, BUN, Glucose
- Fasting requirement is contentious, but in general it is recommended in most birds as birds can regurgitate during anesthesia. However, in smaller birds with high basal metabolic rate fasting is better avoided to minimize the likelihood of hypoglycemia
- Although not as commonly administered as in other domestic species, preanesthetic medication may be useful to minimize the stress and provide analgesia prior to anesthetic induction.
 - In diving birds administration of midazolam with/out butorphanol can substantially reduce the diving reflex.
 - Midazolam can be administered at 0.2-1 mg/kg IM
 - Butorphanol can be administer at 0.2-1 mg/kg IM

Figure 1. A sedated goose following midazolam and butorphanol premedication



- Ratites or bigger birds may require deep sedation or chemical restraint prior to anesthetic induction: alpha 2 agonists with/out dissociatives are used for healthy animals

Inhalant anesthesia

- Modern potent inhalants such as isoflurane, sevoflurane and desflurane are the preferred choice both for anesthetic induction and maintenance
- In most birds that can be handled with little stress, anesthetic induction is achieved by using face mask induction technique, but chamber induction is better for birds that are difficult to control
- Although face masks commercially available for small animals are appropriate for many birds, due to widely varying sizes in beaks, bills and ceres, air-tight face mask placement is not always easy, increasing anesthetic leakage
- Intubating the birds once the anesthesia is induced will provide a secure airway as well as reducing the anesthetic leakage.
- It is better to use non-cuffed ET tubes in birds, but if cuffed tubes are used, beware not to over-inflate the cuff to avoid damage to the trachea.

Anesthetic monitoring & maintenance

- As in other domestic species heart rate, respiratory rate and body temperature are minimal for the physiologic monitoring
- Anesthetic monitoring equipments can be useful and these include ECG and Doppler flow detector
- Most veterinary pulse oximeters are calibrated with mammalian oxygen hemoglobin saturation dissociation curve, so accuracy is uncertain
- For most small birds noninvasive blood pressure readings based on oscillometric principles (e.g. DINAMAP) are difficult to obtain, but for medium size to large size birds the pressure readings may be obtained on peripheral metatarsal arteries
- Small birds may become very hypothermic and external heat sources must be supplied to prevent the animal becoming hypothermic
- Fluids are administered to avoid dehydration and support hemodynamic stability

Recovery

- Keep the patient warm (human infant incubator may be a good external thermal source as well as minimizing handling stress for small birds)
- Provide analgesics
- Attend to airway obstruction
- Reverse any reversible drugs that may prolong the recovery

Anesthesia of small mammals

General considerations

- Animals falling into this category include mice, rats, rabbits, hamsters, Guinea pigs and ferrets, most of which are extensively used for medical research
- Small body size makes venous access, muscular injection and tracheal intubation more difficult

- They have high metabolic rate and this characteristic must be taken into account for preanesthetic preparation and drug dosing

Preanesthetic preparation

- Thorough physical exam and previous medical history check-up
- Fasting is not necessary as vomiting during induction does not occur and also to prevent hyperglycemia due to their high basal metabolic rate
- Water ad libitum until premedication
- Stabilize any fluid deficit or electrolyte deficit
- Most are easily distressed so ensure minimal handling to reduce the stress and excitement
- Pre-existing respiratory disease is not uncommon, so availability to provide O₂ is highly desirable
- In ferrets preexisting adrenal tumors, cardiomyopathy, anemia and endocrinopathies including insulinoma are not uncommon, and thus this must be taken into account in the selection of premedicants

Anesthetic induction

- Either injectables or inhalants are used, and the choice should be based on the animal's temperament, health status, and availability of equipments and other supplies.
- Administration of injectable premedicants or induction agents can be via intramuscular, intravenous, subcutaneous or intraperitoneal routes. Always aspirate before injection.
- Generally, due to the small body size, anesthetic induction through IV route is less practical, and IP injections are more commonly carried out.
- For IP injections, always restrain properly to avoid damaging important vital organs
- Neuroleptanalgesic combination is useful for anesthetic induction
 - Once Innovar-Vet® (Droperidol-Fentanyl) was used to be very popular for anesthetic induction and maintenance of small mammals, but this is no longer marketed in the US.
 - Similar product, Hypnorm® (Fluanison-Fentanyl) is equally effective to provide deep sedation and light anesthesia, but is not available in the US.
 - Other home made neuroleptanalgesic mixtures include
 - fentanyl-midazolam
 - fentanyl-acepromazine
 - morphine-midazolam
 - buprenorphine-midazolam etc.
- Ketamine combined with neuroleptics are commonly used to provide anesthetic induction and maintenance and some examples are:
 - Ketamine + medetomidine
 - Ketamine + xylazine
 - Ketamine + acepromazine
 - Ketamine + midazolam
 - Opioids may be added for synergistic effect to provide better degree of CNS depression, analgesia and muscle relaxation
- Propofol may be used in animals following premedication with IV access: e.g. rabbits (ear vein) and ferrets (cephalic)
- Other injectable anesthetics used for small laboratory mammals include pentobarbital, urethane, chloralose, chloral hydrate, inaction, and tribromoethanol

- Face mask anesthetic induction can be carried out using isoflurane, desflurane or sevoflurane, but often times it is easier to place animals in anesthetic induction chamber (many commercial ones are available)

Endotracheal intubation

- **Rabbits and ferrets**
 - Intubating can be difficult in rabbits because of the long, narrow oropharynx, thick fleshy tongue and long incisors limiting access to the mouth.
 - Although oropharyngeal passage is not as limited in ferrets, intubation is still not without any difficulty. Ferrets are treated similar to cats in dealing for endotracheal intubation and anesthetic management
 - A straight infant size laryngeal, Miller, blade can facilitate the visualization of the laryngeal structure both in rabbits and ferrets
 - For blind intubation in rabbits, the head should be held on extension to provide straight line of the passage of the endotracheal tube
 - Tubes of 2.5 to 4 mm ID are suitable for most rabbits and ferrets
- **Guinea pigs, hamsters, rats and mice**
 - 12 to 18 G plastic intravenous catheters can be used for tracheal intubation
 - Intubation is not typically carried out due to their small tracheal size or narrow oropharynx, so use of face masks are more common for maintaining anesthesia
 - In guinea pigs, maintenance of clear airway is not always easy since nasal and oropharyngeal secretions tend to become viscid during anesthesia and are liable to give rise to obstruction. To ensure a clear airway frequent aspiration of the secreted materials is necessary.

Anesthetic monitoring and maintenance

- Anesthetic depth monitoring using physiologic reflexes such as palpebral, muscle tone, withdrawal reflex, and gross purposeful movement
- Basic physiologic monitoring includes heart rate, respiratory rate, and body temperature
- Because of the very high heart rates, the ECG is almost exclusively required to obtain correct heart rate
- Noninvasive blood pressure monitoring is best achieved in rats and mice using Doppler flow detector and sphygmomanometer
- In ferrets and rabbits, noninvasive blood pressure monitoring can be carried out using oscillometric device (e.g. DINAMAP) and blood pressure cuff
- Pulse oximetry and capnography provide useful adjunctive monitoring to assess ventilatory efficiency
- Fluids need to be administered to avoid hypovolemia and maintain stable hemodynamics

Recovery

- Similar precautions practiced in other species should just as well apply to these species, with particular emphasis on maintaining optimal body temperature, securing a clear airway and providing adequate pain relief

Anesthesia for Reptiles

Physioanatomic peculiarities

- Reptiles are poikilothermic or ectothermic (cold-blooded) and their body temperature and metabolic rates are governed by the ambient temperature
- In snakes the tracheal ring is incomplete but turtles and crocodilians have complete tracheal rings and it is important not to over inflate the ET tube cuff in these species
- Except in crocodilians where the pulmonary morphology is similar to that of the mammals, most reptilians have more primitive lung structures and possess air sacs which do not involve in gas exchanges
- Crocodilians have a similar heart structure to mammals but most reptiles have a three chamber heart with two atria and one ventricle. The ventricle is functionally subdivided into cavum arteriosum, cavum venosum and cavum pulmonale
- Reptiles have an extensive pulmonary shunting. They also undergo extensive anaerobic metabolism which is particularly well developed in aquatic reptiles such as sea turtles. These evolutionary adaptation enable them to sustain hypoxic insult much better than mammals in a low oxygen environment.
- Renal portal circulation may reduce the efficacy of anesthetic drugs when injected in the leg muscles or veins. However, this is of little clinical significance as one can increase the anesthetic dose until the desired effect is achieved
- Reptiles do not possess a true diaphragm but negative pressure pumping system is still used to ventilate
- Respiratory muscles are used both for inspiration and expiration
- In apneic Chelonians ventilation can be supported by moving the legs in and out by changing the volume of coelomic cavity
- The reptile glottis is slit like opening between the arytenoid cartilages and located at the base of the tongue on the floor of the oral cavity
- Low basal metabolic rate

Preparation for anesthesia

- Thorough physical exam and history taking must be carried out. However, due to the danger involved in handling some vicious and venomous species observation of behavioral characteristics in distance may be the only practical pre-anesthetic evaluation process. Any changes in body disposition, the skin condition, discharges from the nostrils and eyes should be carefully assessed.
- The following laboratory data are generally required as minimum: PCV, TP, BUN, Glucose. Blood glucose level is generally lower than mammals (30 – 100 mg/dl)
- Any abnormalities (dehydration, anemia, acid-base imbalance, hypoglycemia) must be corrected prior to anesthetic induction

- Although regurgitation and aspiration is unlikely, fasting is recommended because of impaired digestion.
- Injectable premedicants can provide sedation and facilitate the anesthetic induction using inhalants, and the following agents are used for this purpose
 - Dissociatives (ketamine) and alpha 2 agonist (medetomidine, xylazine) combinations
 - Dissociatives (ketamine, tiletamine) and benzodiazepine (diazepam, zolazepam, midazolam) combinations
 - Muscle relaxants (succinylcholine, gallamine, atracurium)
 - Opioids (etorphine, carfentanyl)
 - Barbiturates (pentobarbital)
 - Sodium channel blockers (tricaine methanesulfonate)
 - Each agent can be further added to different classes for balanced anesthetic approach

Anesthetic induction

- Inhalants are commonly used using clear plastic chamber
- IV injection of anesthetics is not generally practical in these species but induction via IM injection can be carried out using pole syringes or blow pipes
- Propofol IV induction may be carried out in well sedated animals following premedication or in well restrained animals by an expert handler

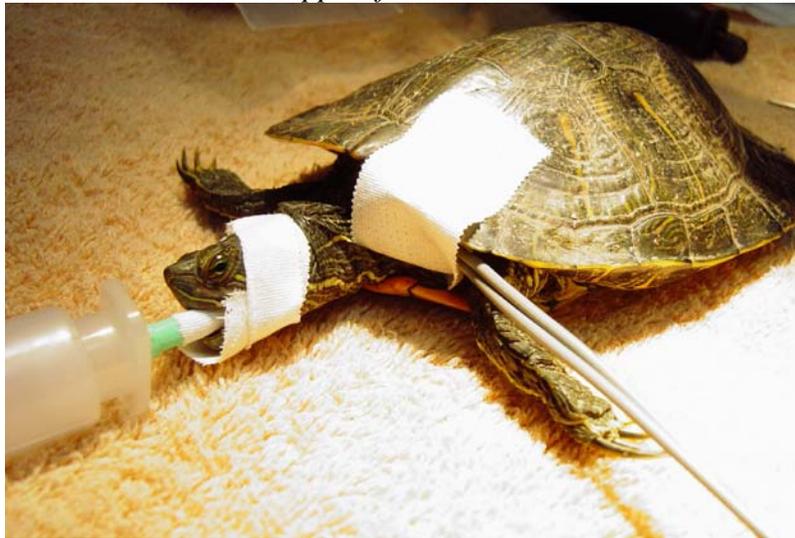
Figure 2. A Gecko being induced with sevoflurane via a face mask



Use of inhalant anesthesia

- Modern potent inhalants such as isoflurane, desflurane and sevoflurane are the preferred choice both for anesthetic induction and maintenance
- Their ability to withhold breath and extensive pulmonary shunting can significantly delay inhalation anesthetic induction
- Due to the danger involved an anesthetic chamber is best utilized for induction
- For many reptiles face masks commercially available for small animals are appropriate
- Intubating the animals once the anesthesia is induced will provide a secure airway as well as reducing the anesthetic leakage.

Figure 3. A small snapping turtle is intubated using an 18 G catheter and is being monitored using a Doppler flow detector



Anesthetic monitoring & maintenance

- As in other domestic species heart rate, respiratory rate and body temperature are minimal for the physiologic monitoring
- An esophageal stethoscope can be useful to monitor both cardiac rate, rhythm, intensity and respiratory rate and rhythm.
- Anesthetic monitoring utilizing combination of an ECG and a Doppler flow detector (typically placed in a site near the heart) will provide useful monitoring of electrical and mechanical activities of the heart
- Due to their thick skin (scales) pulse oximetry and noninvasive blood pressure readings are difficult to obtain.
- Most veterinary pulse oximeters are calibrated with mammalian oxygen hemoglobin saturation dissociation curve, so its accuracy is uncertain
- Small reptiles may become very hypothermic and external heat source (heating pad, forced warm air blanket etc.) must be supplied to prevent the animal becoming hypothermic

Recovery

- Ensure to maintain optimal temperature of the particular species for faster drug metabolism (and recovery)
- Provide a secure and clear airway
- Provide adequate analgesia
- Reverse any reversible drugs that may prolong the recovery

Fish anesthesia

Preanesthetic preparation

- Many species of fish exist with widely varying shape and sizes, and these significantly influence the choice of pre/anesthetics and anesthetic management
- A thorough pre-anesthetic physical exam of the cardiorespiratory system is not readily achievable.
- Although fish do not have lungs and can not aspirate, fasting is recommended as aspirated materials can dislodge within the gills and degrade the water quality

Anesthetic induction

- Anesthetic induction can be as simple as adding anesthetic into the fish tank, but strict planning and attention to the aquatic environment are still of paramount importance for smooth operation and decreased morbidity
- Several anesthetics available as mixed in water include tricaine methanesulfonate, clove oil (eugenol as active ingredient) and isoflurane. In larger fish such as shark, ketamine-medetomidine combination has been successfully used for anesthetic induction and short maintenance of anesthesia

Anesthetic maintenance and monitoring

- For procedures lasting longer than 10 minutes an anesthetic system that allows water to flow over the gills is used.
- A submersible recirculating water pump within the fish tank pumps the anesthetic diluent water into the mouth, past the gills and out through the operculum while the fish is placed in a presoaked foam bed (see figures below)
- The skin that is not in contact with moistened foamed should be kept wet by spraying water periodically to prevent desiccation
- Anesthetic depth monitoring can be carried out by monitoring changes in cardiorespiratory system. An ECG or Doppler flow detector can be used to monitor the rate and rhythm, and respiratory rate can be counted by observing the movement of the operculum.
- If respiration ceases the anesthetic concentration delivered to fish must be reduced or stopped until the fish resumes the respiration
- The fish's heart operates differently to mammals'. The myocardial cells can utilize local glycogen stores for energy instead of relying on blood glucose supply, so the fish's heart can still contract in a clinically dead animal. It is therefore important to evaluate the animal's heart rate in conjunction with other variables when determining anesthetic depth.

Figure 4. A basic set-up for inducing and maintaining small fish using tricaine methanesulfonate (MS 222) diluents via a submersible recirculating water pump and hoses



Figure 5. A gold fish is placed on a presoaked foamed and ready for a quick surgical removal of the head tumor. The diluent anesthetic is constantly being circulated through the open mouth, gills and out of the operculum using the water pump and hoses



Recovery

- Recovery is achieved by placing the fish in an anesthetic-free water
- The water is aerated and the animal's mouth is oriented to the water flow
- If the animal is not breathing on its own, it is assisted with water to flow into the mouth and over the gills.

- As the fish recovers, respiration increases, fin starts to move and then the fish swims with progressively better coordination.
- Most recover within 5 minutes after being placed in clear water, and animals taking longer than 10 minutes are suspected to have been overdosed or medically compromised

Further readings

- Thurmon, Tranquilli and Benson Veterinary Anesthesia Williams and Wilkins 1996
- Hall, Clarke, and Trim Veterinary Anaesthesia WB Saunders 2001
- Muir, Hubbel and Skarda A handbook of Anesthesia Mosby 1999
- Greene Veterinary Anesthesia and Pain Management Secrets Hanley and Belfus 2002
- Heard Analgesia and Anesthesia Exotic Species The Veterinary Clinics of North America Philadelphia WB Saunders 2001
- Seymour and Gleed BSAVA Manual of Small Animal Anaesthesia and Analgesia BSAVA Publication 1999