Reptile Anesthesia & Analgesia

Javier G. Nevarez DVM, PhD, DACZM, DECZM (Herpetology)

LafeberVet

RACE Program 1124336

DEFINITIONS

- General anesthesia = induced unconsciousness characterized by controlled reversible depression of the CNS and analgesia. Patients under general anesthesia are not arousable and the reflex functions are attenuated. Surgical anesthesia is a deeper level that allows for painless surgery.

- Sedation = a state of central depression and drowsiness with the patient unaware of its surroundings.

- Tranquilization = the relief of anxiety and a state of relaxation while the patient is aware of its surroundings.

DEFINITIONS

- Analgesia = the freedom or absence of pain.
- Local analgesia = loss of sensation in a circumscribed area.
- Regional analgesia = loss of sensation or insensibility in a larger but limited body area.

GOALS

- Balanced anesthesia
- Pre-emptive analgesia

- Facilitates handling and induction
- Reduce anesthetic requirements

ANATOMY AND PHYSIOLOGY

- Poikilothermic species
- Lack epiglottis
- Lungs differ in lizards, chelonians and snakes
- Lack functional diaphragm
- Three chamber heart (four in crocodilians)
- Renal-portal system

SIGNS OF PAIN

- Change in normal behavior
- Reluctance to move
- Abnormal ambulation
- Dull and closed eyes
- Anorexia
- Hunched posture
- Aggression in passive animal
- Passive behavior in normally aggressive animals
- Elevated and extended head
- Lameness
- Decreased tendency to coil (snakes)
- Aerophagia
- Color changes (darker or paler)

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A Critical Review on the Pharmacodynamics and Pharmacokinetics of Non-steroidal Anti-inflammatory Drugs and Opioid Drugs Used in Reptiles

Allison Kah Yann Ting [a], Vanessa Shu Yu Tay [a], Hui Ting Chng [a], Shangzhe Xie [b,*]

[a] National University of Singapore, Department of Pharmacy, 18 Science Drive 4 Blk S4A Level 3, Singapore, 117559
[b] Mandai Wildlife Group, 80 Mandai Lake Road, Singapore, 729826

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ABSTRACT

Non-steroidal anti-inflammatory drugs (NSAIDs) and opioids are analgesics used for moderate to severe pain in many animals, including reptiles. However, reptilian dosing regimens are often extrapolated from other animal species. This is not ideal as inter- and intra-species variability in physiology may result in varied drug disposition. Therefore, this critical review aims to collate data from pharmacological studies of selected NSAIDs and opioids performed in reptile and provide an analysis and discussion on the existing pharmacodynamic knowledge and pharmacokinetic data of NSAIDs and opioids use in reptiles. Additionally, key pharmacokinetic trends that may aid dosing of NSAIDs and opioids in reptiles will also be highlighted. Most of the existing reports of NSAID used in reptiles did not observe any adverse effects directly associated to the respective NSAID used, with meloxicam being the most well-studied. Despite the current absence of analgesic efficacy studies for NSAIDs in reptiles, most reports observed behavioural improvements in reptiles after NSAID treatment. Fentanyl and morphine were studied in the greatest number of reptile species with analgesic effects observed with the doses used, while adverse effects such as sedation were observed most with butorphanol use. While pharmacokinetic trends were drug- and species-specific, it was observed that clearance (CL) of drugs tended to be higher in squamates compared to chelonians. The half-life ($t_{1/2}$) of meloxicam also appeared to be longer when dosed orally compared to other routes of drug administration. This could have been due to absorption-rate limited disposition. Although current data provided beneficial information, there is an urgent need for future research on NSAID and opioid pharmacology to ensure the safe and effective use of opioids in reptiles.

ANALGESIA- MORPHINE

- Pure mu agonist
  - Increased tolerance to thermal stimulus in RES, BD, tegu, crocodiles and anole lizards, and electrical in iguanas and BD
  - Deacreased duration of limb retraction in formalin test in Speke's hinged tortoise
  - Associated with severe (up to 80%) respiratory depression in RES
- Dosage: 1.5-5 mg/kg q24h; 10-20 mg/kg in BD

ANALGESIA- HYDROMORPHONE

- Pure mu agonist
  - Increased tolerance to thermal stimulus in RES
  - Plasma levels in B. dragons
- Dosage: 0.5 -1 mg/kg
  - Sedation at higher doses

ANALGESIA- FENTANYL

- Pure mu agonist
  - Plasma concentrations detectable in ball pythons and prehensile-tailed skinks with fentanyl patch
  - No evidence of efficacy in snakes using patches
- Dosage
  - 0.05 mg/kg in RES and black bellied slider
  - 2.5-12.5 mcg/h

ANALGESIA- TRAMADOL

- Weak mu agonist, inhibits reuptake of serotonin and norepinephrine
  - Increased tolerance to thermal stimulus in RES, and to electrical stimulus in BD
  - Plasma concentrations determined in sea turtles, bearded dragons
  - Respiratory depression in RES was less than with morphine
  - Falling out of favor with anesthesiologists due to lower clinical effects in practice
- Dosages in RES 5-10 mg/kg q 72 h PO

ANALGESIA- MELOXICAM

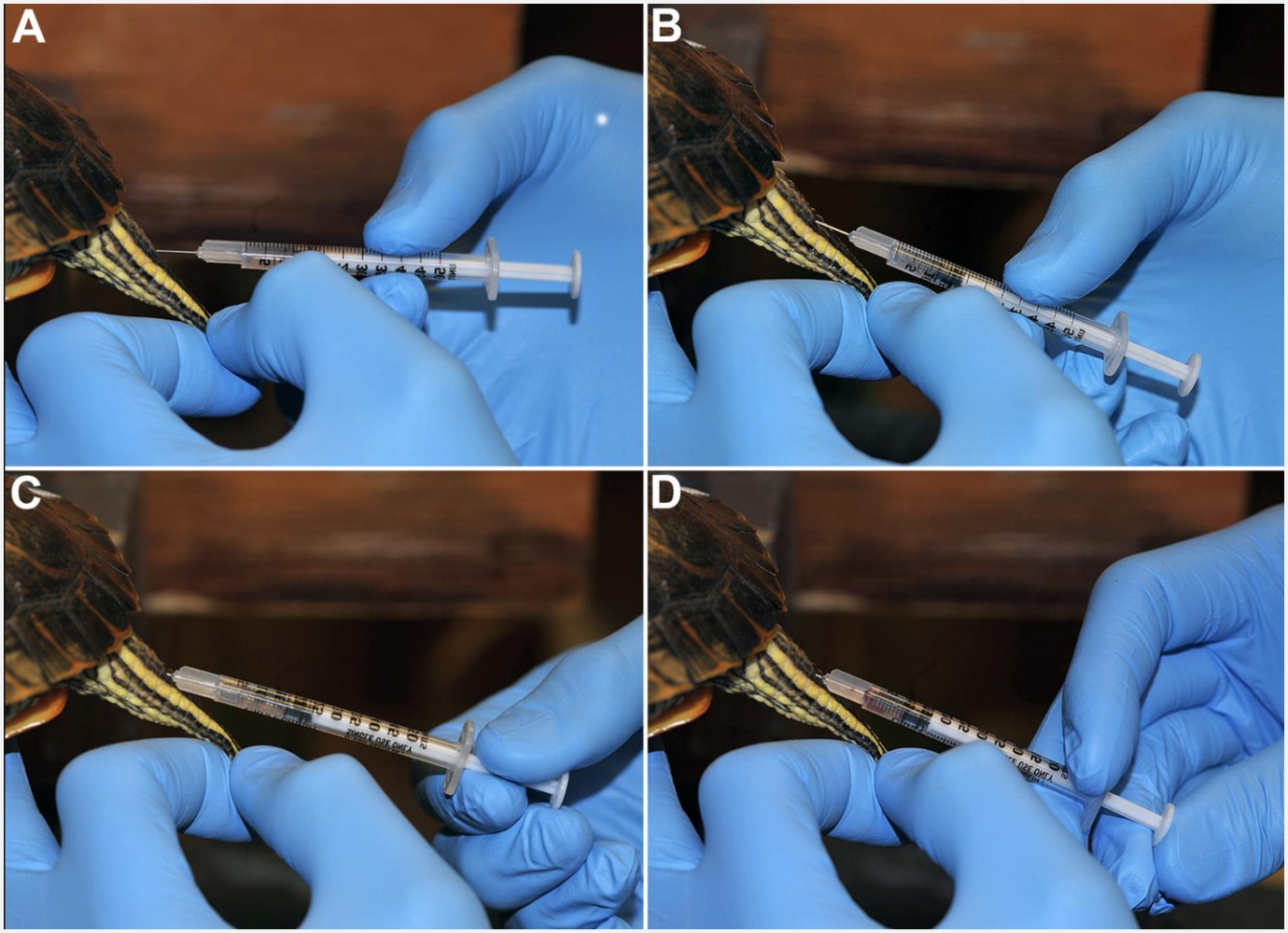
- Nonsteroidal antiinflammatory drug, cyclooxygenase (COX)-2 specific inhibitor
  - Increased the tolerance to electrical stumulus in bearded dragon at 0.4 mg/kg IM
  - Did not change physiologic parameters in ball pythons at 0.3 mg/kg, or hematological and biochemical parameters in iguanas at 0.2 mg/kg
  - Plasma concentrations determined in RES and iguanas
- Dosage 0.5 mg/kg q 24 h

REGIONAL ANALGESIA/ANESTHESIA

- Intrathecal spinal analgesia in RES

  - Lidocaine – 1 hr.
  - Bupivacaine – 2 hr.
  - Morphine – 48hr.
  - Preservative free formulations

  - *Mans, C. Clinical technique: intrathecal drug administration in turtles and tortoises. Journal Exotic Pet Medicine 23 (2014), pp. 67-70.*



Journal of Exotic Pet Medicine
Volume 23, Issue 1, January 2014, Pages 67-70

Topics In Medicine And Surgery

CLINICAL TECHNIQUE: Intrathecal Drug Administration in Turtles and Tortoises

Christoph Mans Dr. med. vet.

REGIONAL ANALGESIA/ANESTHESIA

Vet Anaesth Analg. 2021 Sep;48(5):798-803. doi: 10.1016/j.vaa.2021.06.012. Epub 2021 Jul 2.

Evaluation of neuraxial administration of bupivacaine in bearded dragons (Pogona vitticeps)

Tatiana H Ferreira [1], Dustin M Fink [2], Christoph Mans [2]

Am J Vet Res. 2021 Dec 27;83(3):212-217. doi: 10.2460/ajvr.21.08.0104.

Neuraxial administration of morphine combined with lidocaine induces regional antinociception in inland bearded dragons (Pogona vitticeps)

Dustin M Fink, Tatiana H Ferreira, Christoph Mans

Vet Anaesth Analg. 2019 Jan;46(1):126-134. doi: 10.1016/j.vaa.2018.09.001. Epub 2018 Sep 19.

Evaluation of neuraxial anesthesia in bearded dragons (Pogona vitticeps)

Tatiana H Ferreira [1], Christoph Mans [2]

INDICATIONS FOR TRANQUILIZATION

- Restraint of fractious animals
- Ultrasound
- Radiographs
- Transport
- Venipuncture
- FNA

INDICATIONS FOR SEDATION

- Restraint of fractious animals
- Ultrasound
- Radiographs
- Transport
- Venipuncture
- FNA

- Minimally invasive procedures combined with local analgesia

INDICATIONS FOR ANESTHESIA

- Surgery
- Endoscopy
- Invasive procedures
  - FNA

INJECTABLE AGENTS

- Ketamine
- Dexmedetomidine
- Midazolam
- Propofol
- Alfaxalone

ALFAXALONE

- Neuroactive steroid agent
- Rapid induction and recovery
- IV and IM routes
- Induction (5-10mg/kg), maintenance CRI and bolus
- Minimal cardiorespiratory depression*

INHALATIONAL AGENTS-ISOFLURANE

- Minimal metabolism, eliminated by lungs
- Right-to-left cardiac shunting might result in mismatch concent. gas and anesthetic depth
- Dose dependent cardiovascular depression
- Minimum anesthetic concentration (MAC) 1.8-2.1% iguana, 1.37-1.71% monitors, 1.31-2.49 % rat snake
- Induction variable %, maintenance 2-3%

INHALATIONAL AGENTS- SEVOFLURANE

- Faster induction and recovery than isoflurane in iguana, but similar recovery in monitors
- No significant cardiopulmonary differences with isoflurane in iguanas
- Less irritant to airways than isoflurane
- MAC 3.0-3.2% iguana, 2.05-2.97% monitors, 1.85-2.99% rat snakes
- Induction variable %, maintenance 3.5-4.5%

PREMEDICATION

- Combination of:
- Ketamine
- Dexmedetomidine
- Midazolam
- Propofol
- Alfaxalone
- Hydromorphone/morphine

INDUCTION

- Propofol
- Alfaxalone

MAINTENANCE

- Isoflurane or sevoflurane

EXAMPLE 1
TRANQUILIZATION TO SEDATION

- Sulcata for exam and venipuncture
- Option A
  - Midazolam, ketamine +/- dexmed. IM or IV
- Option B
  - Alfaxalone IM

EXAMPLE 2

- Esophagostomy tube
  - Midazolam IV or IM for sedation
  - Hydromorphone or morphine IM
  - Meloxicam
  - Local lidocaine block

EXAMPLE 3

- Rads., Gastroscopy +/- coelioscopy of Alligator snapping turtle
- Premed/induction
  - Hydromorphone 1mg/kg
  - Ketamine 2-5 mg/kg
  - Dexmedetomidine 0.25-0.5 mg/kg
  - Midazolam 0.5-1 mg/kg
  - IV injection
- Maintenance
  - Iso

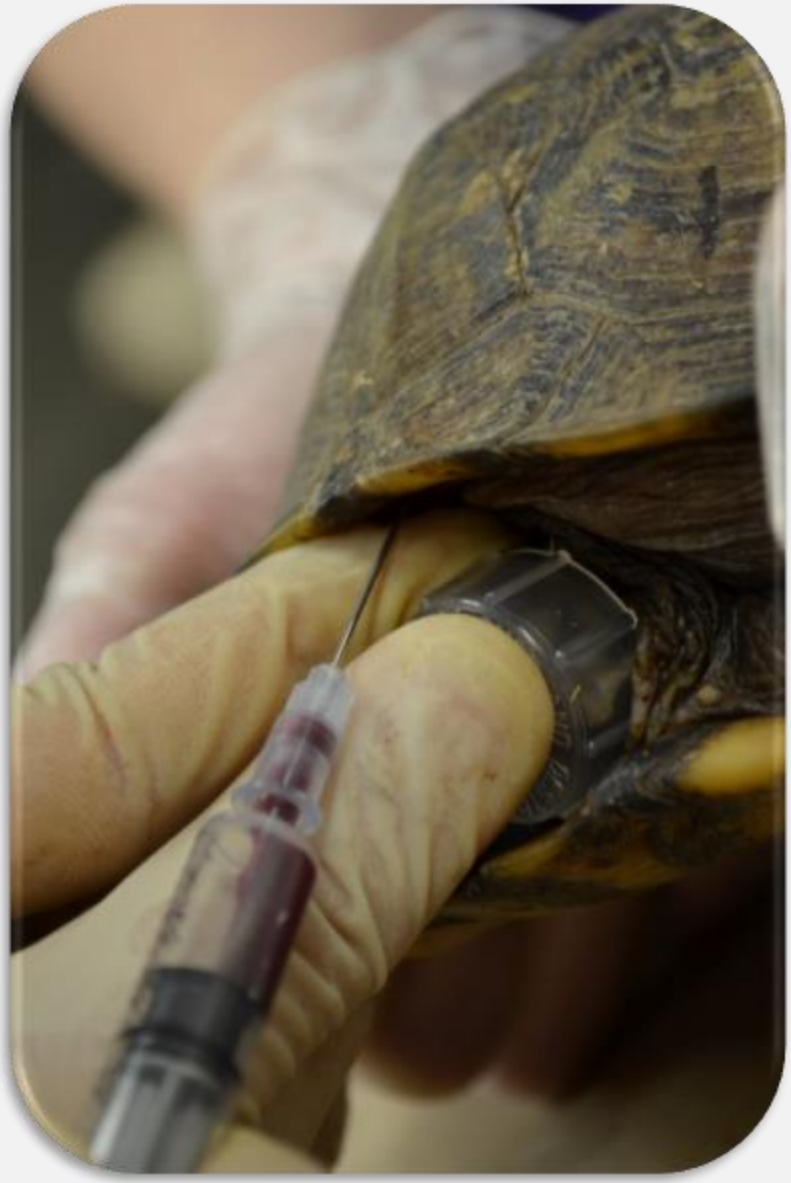
EXAMPLE 4

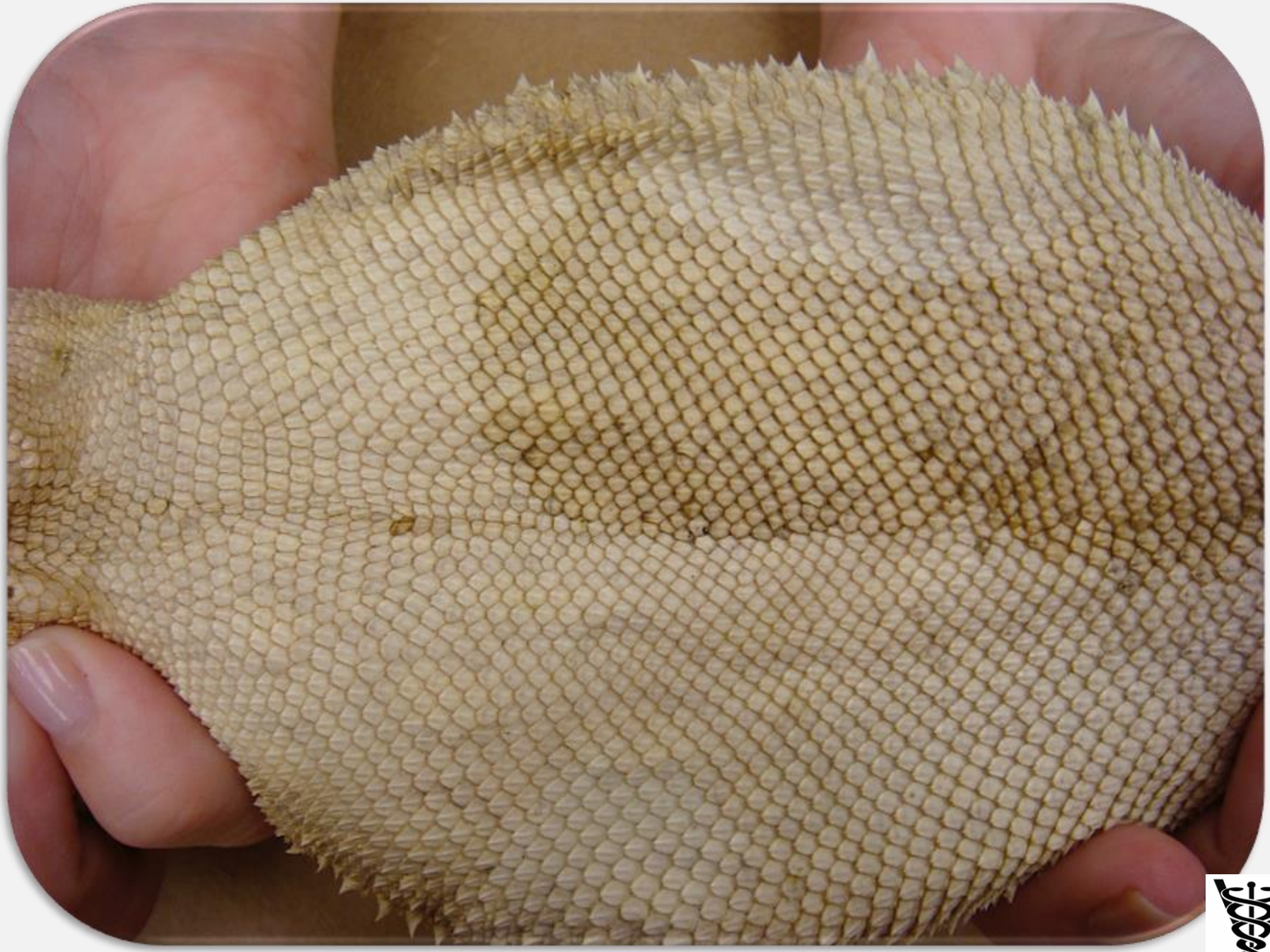
- Rads., Gastroscopy +/- coelioscopy of Alligator snapping turtle
- Premed/induction
  - Hydromorphone 0.5 - 1mg/kg
  - Propofol 10mg/kg or Alfaxalone 10-20 mg/kg
- Maintenance
  - Iso

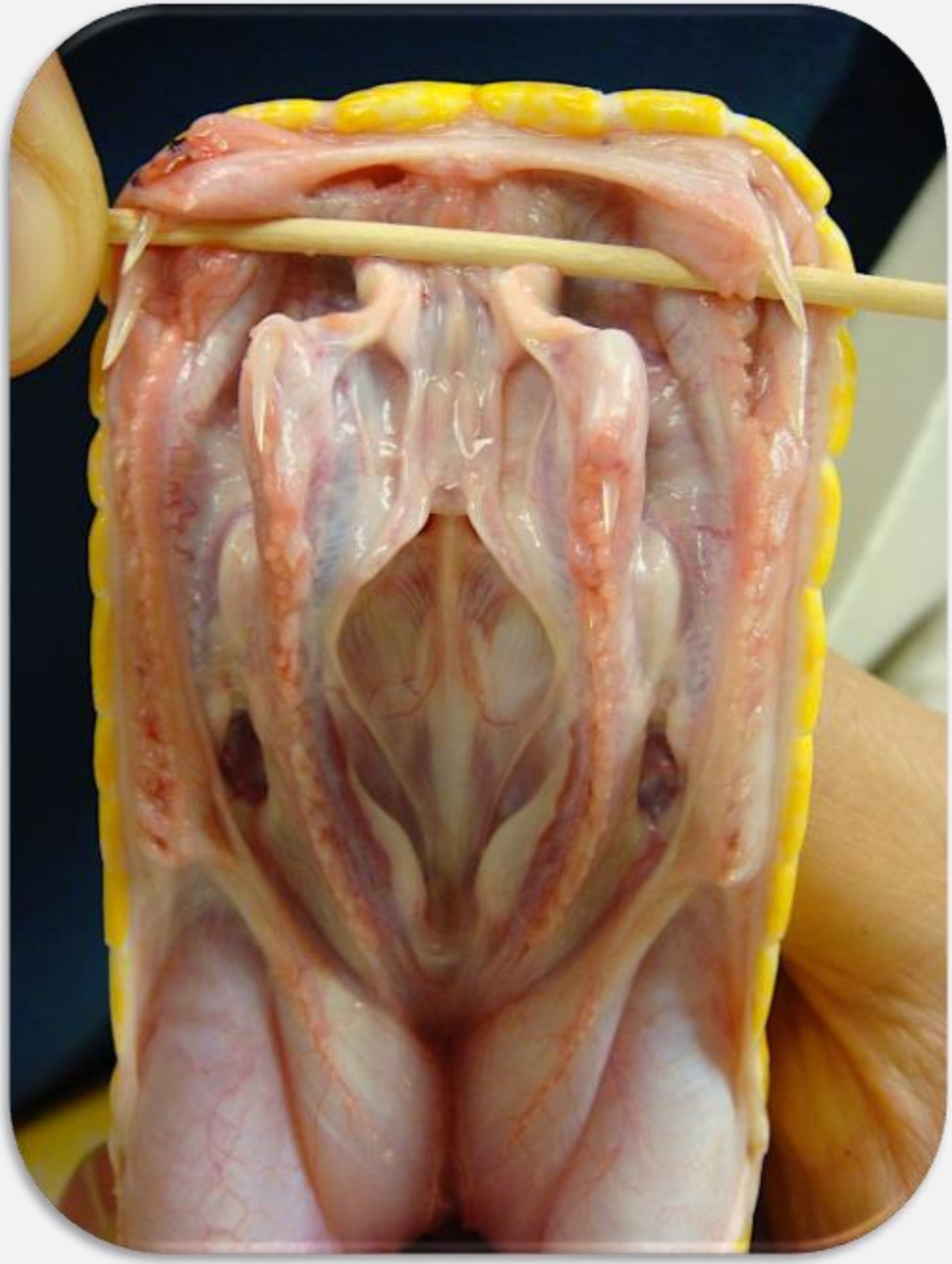
EXAMPLE 5

- Green iguana coelomic surgery
- Premed/induction
  - Hydromorphone 1mg/kg
  - Ketamine 2-5 mg/kg
  - Dexmedetomidine 0.25-0.5 mg/kg
  - Midazolam 0.5-1 mg/kg
  - IV injection
- Maintenance
  - Iso

INJECTION SITES





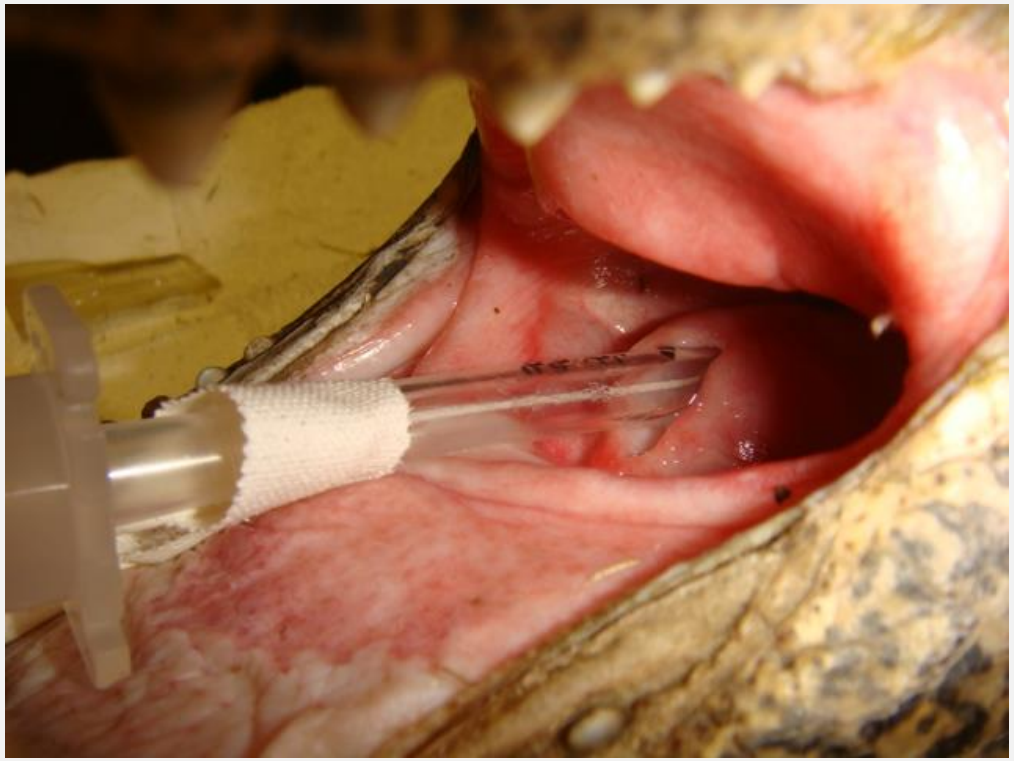


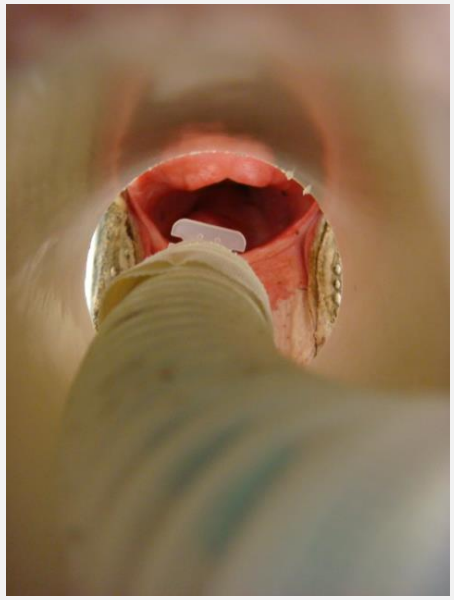
INTUBATION- CHELONIANS

INTUBATION- SNAKES

INTUBATION- LIZARDS

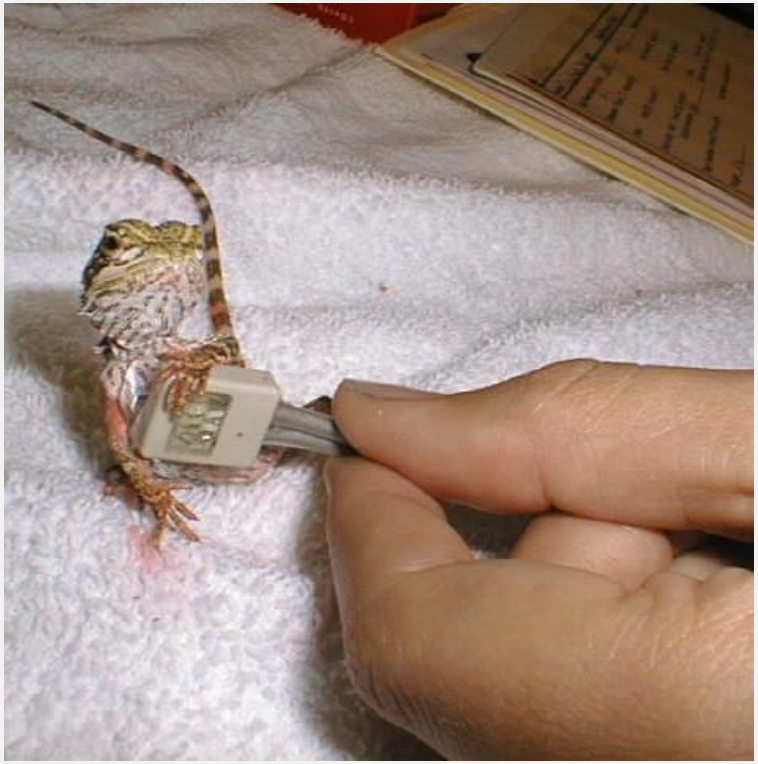
INTUBATION- CROCODILIANS





PATIENT MONITORING

- Same principles as other species
- Corneal reflex is good indicator of depth and death
- Heart rate: Doppler, ECG
- Respiratory rate: often need IPPV
  - DO NOT EXCEED 15 – 20mmHg
  - POP-OFF valve MUST REMAIN OPEN after breathing
  - 2 – 4 breaths/min
- Temperature: KEY for successful anesthesia
  - Aim for 90 - 95^{o}F during anesthesia



CARDIOVASCULAR SUPPORT

- Fluid therapy
  - Intravenous (IV)
  - Intraosseous (IO)
  - Subcutaneous (SC)
  - Intracoelomic (Ice)

IV ACCESS

- Jugular vein
- Ventral coccygeal vein
- Ventral abdominal vein
- Sub-carapacial

IO ACCESS

- Femur
- Tibia
- Carapace/plastron
- IO access can be used the same as IV but with slower volume of infusion

IO CATHETER

TEMPERATURE SUPPORT

- Forced air warmer
- Heat blankets
- Heat lamps
- Warm fluids
- Rice/bean bags
- Etc..

HYPOTHERMIA

- Heat loss
  - Convection
    - Air exchange at body surface
  - Radiation
    - Heat loss to surfaces and environment
  - Conduction
    - Heat loss from contact (i.e. cold table)
  - Evaporation
    - Heat loss from lungs, skin, exposed tissues

PREVENTING HYPOTHERMIA

- Forced-air warmers
  - Can reduce convection, conduction, and radiation losses depending on the blanket type
- Heating pads
  - Reduce conduction losses
- Heat lamps
  - Reduce radiation losses
- Water bath
  - Reduce conduction, radiation losses
- Bean/rice stockings
  - Reduce radiation losses

PREVENTING HYPOTHERMIA

	Convection	Conduction	Evaporation	Radiation
Forced-air warmer	X	X		X
Heating pads		X		
Heat lamp				X
Rice/bean stockings				X
Water baths		X		X

RECOVERY

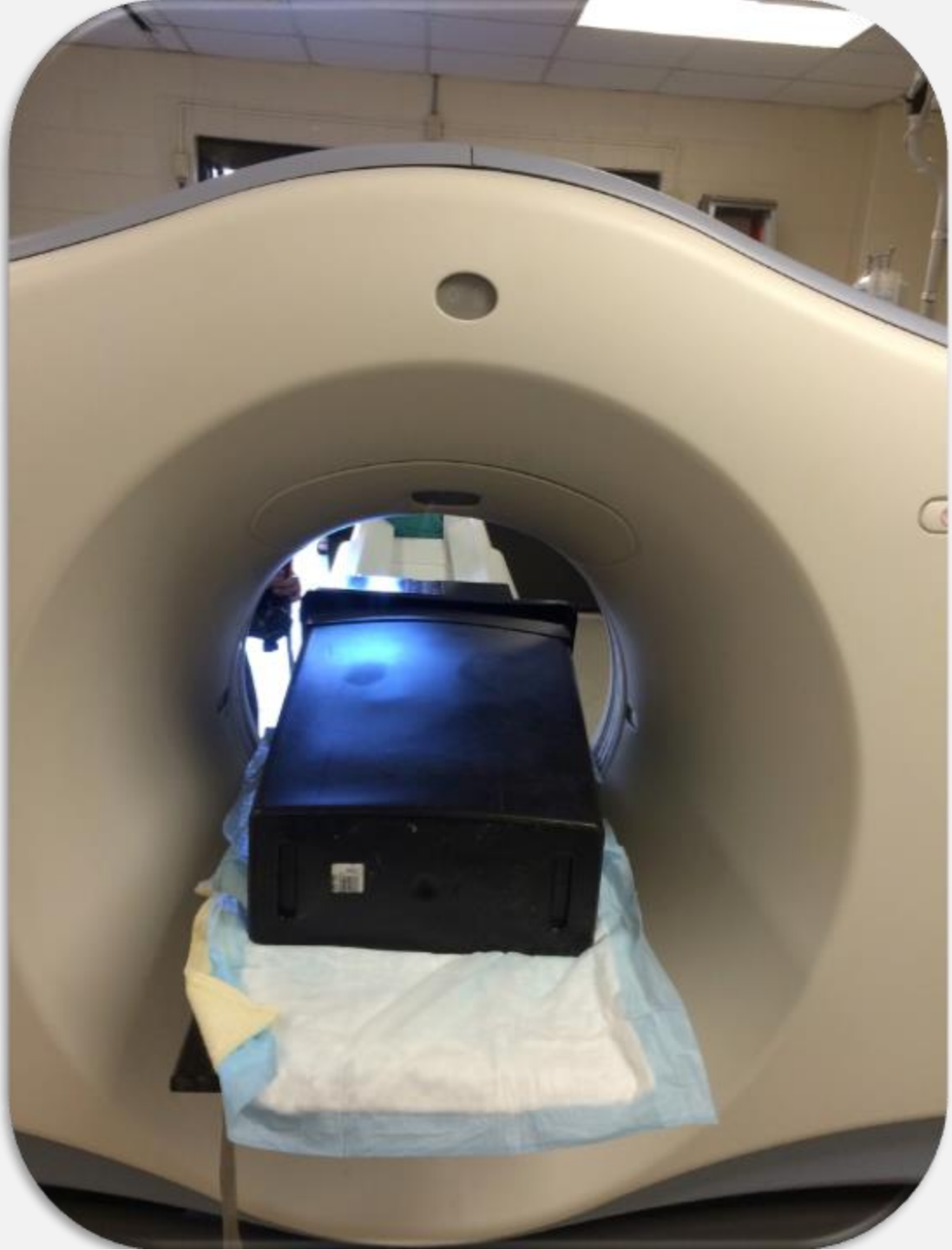
- Wean off gas before the end of procedure
- Maintain O_2 at low flow rate
- KEEP WARM!!!!!!!!!!!!!!!!
- Breathing stimulus
  - Reptiles: O_2

KEY TO SUCCESS

1. Keep patients warm
2. Keep patients hydrated
3. Use balanced anesthesia and analgesia
4. Discontinue O2 before end of surgery

NOT EVERY PATIENT NEEDS DRUGS

RADS AND CT



QUESTIONS?