

Amphibian Medicine and Therapeutics

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Amphibians

- Class Amphibia
 - Approx 6000 recognized species
 - 3 extant orders
 - Anura
 - Caudata (Urodela)
 - Gymnophiona (Apoda)

Order Anura

- Frogs and toads
- Approx 90% of known amphibian species
- Wide range of species and habitats

Order Caudata

- Salamanders and newts
 - Aquatic/semiaquatic
 - Regeneration of tissues
 - Larval forms- external gills
 - Several families with incomplete metamorphosis
 - Neotony

Order Gymnophiona

- Caecilians
 - No metamorphosis
 - Annuli create ribbed appearance
 - Rare
 - Often underground/aquatic

Special considerations

- Husbandry/environment
- Anatomy/physiology
 - Metamorphosis
- Disease processes

Husbandry/environment

- Complex and varied, with some general themes
- When in doubt, turn to natural history of species
- Temperature
 - Generally lower than most reptiles
 - POTZ
- Humidity
- Water quality
 - Extremely important

Anatomy/Physiology

- Skin
- Respiratory system
- GI
- Renal
- Musculoskeletal system

Skin

- Semi-permeable
 - Generalized
 - Localized (tree frogs, toads)
- Glands for secretions
 - Cardiac glycosides in Toads (Bufonidae/Anaxys)
 - Neuromuscular blockers (dart frogs)
- Shed usually ingested
- No fat within SC space

Respiratory system

- General respiratory strategies
 - Branchial, buccopharyngeal, cutaneous, pulmonary
- Larval form
 - Gills
- Adults
 - Lungs
 - Gills present in some species (neotony)
 - Cutaneous respiration

GI

- Larval form
 - Aquatic
 - Omnivores, herbivores, carnivores
 - Keratinized mouth parts
 - Filter feeders
- Adults
 - Carnivorous with simple GI
 - Aquatic and terrestrial
 - Changes with metamorphosis
 - Teeth

Renal

- Paired coelomic kidneys
 - Pronephric to mesonephric depending on species
- Urinary bladder present
- Excretions
 - Urea- most species
 - Ammonia
 - Uric acid

Musculoskeletal

- Anurans
 - 4 limbs, well developed for jumping/climbing
- Caudates
 - 4 limbs, reduced size, swimming and walking
- Gymnophiona
 - Limbless

Amphibian examination

- Largely visual depending on species
- Starts well before seeing the animal!
 - History
 - Signalment
 - Where acquired
 - Medical history
 - Husbandry
 - Housing
 - Size
 - Water quality
 - Diet
 - Temp/humidity

Amphibian examination

- Moistened powder free gloves
 - Reduces disease transmission
 - Delicate skin

Amphibian therapeutics

- Medication routes
 - Depends on the type of medication/disease condition/current health state
- PO
- IM
- SC/IL
- IV
- Topical
- Environmental

Oral medications

- Generally compounded liquids
- Challenges
 - Species/size
 - Volume to be administered
 - Temperament
 - Ability to handle safely

Oral medications

- Administering meds
 - Measuring the amount
 - Insulin syringes without needles
 - Micropipettes
 - Expensive for uncommon species
 - Opening the mouth
 - Small guitar picks
 - Rigid paper (business cards)

Intramuscular injections

- More direct application
- Warning with selected medications
 - Enrofloxacin- pH concerns
- Injection sites
 - Forelimb mm.
 - Hindlimb mm.

Subcutaneous/intralymphatic injections

- Lack of fat in SC, decreased space
- Over urostyle
 - Intralymphatic injections
- Limited medications
- Direct route
- Great route for fluid therapy

Intravenous administration

- Lack of great options for sites and meds
- Sedation needed
 - Selected cases

Blood collection sites

Anurans

- Ventral abdominal vein
- Lingual plexus
- Femoral vein
- Heart
- Facial vein/musculocutaneous vein

Salamanders/newts

- Ventral tail vein
- Heart
- Femoral vein

Topical medication

- Different than topical meds for mammals
- Skin permeability
 - High level of absorption
 - Administration of injectable meds topically
- Limited medications
 - Watch for pH issues
 - Watch for carriers in medications
 - Avoid oily meds

Environmental applications

- Temperature
 - Cooler temperatures are better for amphibians
 - Heat stress possible
- Fluids
 - Intralymphatic fluids
 - Soaking
 - Intracoelomic?

Current updates

- Exotic Animal Formulary 5th ed, 2017
 - Literature review from 2008-2016
- Updates on amphibian therapeutics
 - Analgesia
 - Sedation/anesthesia
 - Antibiotics
 - Antifungals
 - Nutritional supplementation

General supportive care

- Fluid therapy
 - Fluid choice
 - Amphibian ringers solution
 - Plasmalyte with dextrose
 - Balanced electrolyte solutions
 - Does it matter?
 - Osmolality vs volume replenishment

Analgesia

- What do we know?
 - Dosing for opioids may be radically different than mammals
 - Buprenorphine 38-50mg/kg in some species (red spottend newts, leopard frogs)
 - NSAIDs
 - Meloxicam reduces circulating prostaglandin E2 levels 24hr post 0.1mg/kg dosing in American bullfrogs
 - Flunixin meglumine appears to be the NSAID of choice in *Xenopus*

Analgesia

- Don't we know?
 - Pretty much everything else
 - How effective is meloxicam as an NSAID?
 - What are the appropriate opioid pain medications?

Anesthesia/sedation

- Injectable meds
 - Alfaxalone
 - IM, IV, intracoelomic
 - Bath immersion
 - Propofol
 - Intracoelomic
 - Deep anesthesia in tiger salamanders
 - Mild sedation in Sonoran desert toads
 - Immersion
 - African clawed frogs

Anesthesia/sedation

- Topical
 - Metomidate hydrochloride
 - Bath immersion
 - Great for sedation in *Rana pipens*, but not surgical anesthesia
 - Sevoflurane
 - Topical gel mixture (distilled water, non-spermicidal jelly, sevoflurane)
 - American tree frogs
 - Isoflurane
 - Topical gel mixture (distilled water, non-spermicidal jelly, isoflurane)
 - American tree frogs
 - Noted skin irritation with application

Anesthesia/sedation

- Topical anesthesia
 - Tricaine methanesulfonate (MS-222)
 - Buffer to pH 7.0
 - Sodium bicarbonate
 - Varying ranges of effect
 - Much higher dosing than for fish
 - 0.5-2g/L
 - Bath to effect
 - Reverse with fresh water baths

Antibiotics

- Generalized bacterial infections
 - Common offenders
 - *Aeromonas*
 - *Pseudomonas*
 - *Chlamydia/Chlamydophila* spp.
 - *Streptococcus*
 - *Staphylococcus*
 - All antimicrobial choices should be made based on clinical signs and appropriate diagnostics
 - Culture and sensitivity
 - Gram stain

What's new?

- Enrofloxacin
 - Several tissue concentration studies supporting 10mg/kg dosing
 - *Xenopus laevis*- IM or SC route
 - Coqui frogs- topical route
 - Increased concentration in the kidneys and liver

Antifungals

- Chytridiomycosis
 - *Batrachochytrium dendrobatidis*
 - Varying species of amphibians affected
 - Tadpoles and some species may be subclinical carriers
- Clinical signs
 - Death
 - Dehydration
 - Skin lesions
 - More likely from secondary infections

Antifungals

- Chytridiomycosis
 - Life cycle
 - Temperature dependent (23C critical temp)
 - Various treatments have been evaluated
 - Always confirm treatment efficacy with PCR testing
 - Subclinical infections common

Antifungals

- Treatments
 - Temperature
 - 30°C x10d for bullfrogs
 - Caution with sensitive species
 - Flufenicol
 - Reduces zoospore numbers, does not eliminate infection
 - GI and renal toxicity in tadpoles at 100ug/mL
 - Chloramphenicol
 - Continuous emersion with aggressive supportive care in debilitated Australian green tree frogs

Antifungals

• Treatments

- Itraconazole
 - Topical treatments appear to be more effective for chytridiomycosis
 - Bath treatments x5min at varying concentrations
- Terbinafine
 - Topical low dose therapy
 - Various species in study, cleared infections, confirmed by PCR

Antifungals

• Treatments

- Voriconazole
 - Topical spray daily for 7 days
 - Worked in vivo for various species of poison dart frogs
 - Poor results in vitro

Antifungals

• *Batrachochytrium salamandrivorans*

- Salamanders and newts
- Combination therapy for 10 days
 - Voriconazole, Polymixin E, Elevated temperature
- No effect at lower temperature (20 vs 15 oC)

Anti-virals?

- **Ranavirus**
 - Iridoviridae family
 - Large double stranded DNA viruses
 - Frog virus 3 (FV-3) and FV-3 like viruses
 - Worldwide distribution
 - Transmission
 - Relatively stable in aquatic environments
 - Contaminated soil, direct contact, ingestion of infected tissues

Anti-virals?

- **Ranavirus**
 - No current treatments noted
 - Environmental disinfection
 - Nolvasan 0.75% for 1 min contact time
 - Sodium hypochlorite 3% for 1 min contact time
 - Virkon S 1.0% for 1 min contact time
 - Dessiccation and exposure to heat (140 oF) for 15-30 min

Nutritional therapies

- **Vitamin A**
 - Products
 - Aquasol A
 - Vitamin A gel caps
 - Route
 - Topical application of aquasol improved circulating vitamin A levels in foam nesting frogs compared to fortified vitamin A supplement over crickets
 - Formulation
 - Preformed vitamin A
 - Dietary carotenoids?
 - Increased plasma retinol levels in false tomato frogs fed crickets injected with mixed carotenoids
 - Research deficient

Continuing amphibian education

- Professional groups
- Continuing education
- Books
- Journal articles

Professional Groups

- ARAV
- AAZV
- WAVMA

Recommended literature

- Journals
 - Journal of Herpetological Medicine and Surgery
 - Veterinary Clinics of North America: Exotic Animal Practice
 - Diseases of Aquatic Organisms
 - Journal of Zoo and Wildlife Medicine

Recommended literature

• Books

- Amphibian Care and Captive Husbandry
- Exotic Animal Formulary, currently in 5th ed.
- Current Therapy in Reptile Medicine and Surgery
- Manual of Exotic Pet Practice
- Reptile Medicine and Surgery, 2nd ed. (New edition coming soon!)

Summary

- Amphibian medicine and therapeutics are constantly being updated
 - Mostly driven by concerns of global outbreaks of Chytridiomycosis, or by lab animal medicine
- Large deficits are present in terms of analgesia and varying antibiotic options
- Using evidence based medicine can drive us to identify and reduce these deficiencies through further research
