FLUORESCENCE PHOTOBIOMODULATION THERAPY

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PHOTOBIOMODULATION











































CLINICAL CASES



























- Considerations for euthanasia
- Quality of care vs Quantity
 Does the rehabilitator accept that
 species?
- Does the state allow the species to be rehabilitated?
- Is the survivability of the animal high or low?
- Is the injury/illness treatable and the animal can survive in the wild?
- Migratory Birds Permit Regulations USFWS
 - Acquirements USFWS You are required to extinctible any migratory brid that will not be able, even after medical treatment and rehab, to perch upright and/or ambuilde without infilicing additional injuites to itself. You must euthanize any brid that is bind Durant argots with loss of vision in 1 eye not a condicide for reference.
 - You must euthanize any bird that has sustained an injury requiring amputation
 wing at the elbow (humero-ulna joint) or above

 - a leg or a foot
 DO NOT TREAT TO PLACE!

Understanding the Rules and Regulations of Wildlife Rehabilitation

Stephanie Kadletz MNR, CWR, CET Auburn University Raptor Center College of Veterinary Medicine

01 What is Wildlife Rehabilitation? 02 Federal Regulations 03 State Regulations

04 County/City Ordinances

16 U.S.C. 703-712 - Migratory Bird Treaty Act of 1918 (MBTA)

- Probits the take (including killing, capturing, selling, trading, and transport) of protected migratory bird species without prior authorization by the Department of the Interior U.S. Fish and Wildlife Service. (1)
- S0 CFR 10.13 List of Birds Protected by the Migratory Bird Treaty Act.

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Required Permits

Migratory Bird Permits

 No person may take, posses, import, export, transport, sell, purchase, barter, or offer for sale, purchase, or barter, any migratory bird, or the parts, nests, or eggs of such bird except as may be permitted under the terms of a valid permit issued. (2)

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General Permit Procedures (50 CFR 13)

- Must have a valid permit issued by the USFWS before permit activities can begin.
- Correct permit type and application forms
- Applicable experience, enclosures, etc.
- <u>https://www.fws.gov/program/migrator</u> <u>y-bird-permit/permit-types-and-forms</u>

Permit Types (3)

- Abatement
 Depredation
 Eagle Aviary
 Eagle Depredation
 Eagle Exhibition
 Eagle Parts for Native American Religious
 Purposes

- Eagle Parts for Native American Religious Purposes
 Eagle Scientific Collection
 Eagle Take Associated with, but not the Purpose of, and Activity (Incidental Take)
 Eagle take of Golden Eagle Nests during Resource Development or Recovery
 Eagle Transport INTO the US for Scientific or Exhibition Purposes
- Education Special Purpose Possession Possession Live and/or Dead Migratory Birds for Educational Purpore: Niligratory Bird Remains Nature American Tribal Eagle Retention Raptor Propagation Salvage Scientific Collecting Special Canada Goose (Miscellaneous (Special Purpose) Utility (Special Purpose) Utility (Special Purpose) Utility (Special Purpose) Utility (Special Purpose) Waterfowl Sale & Disposal

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Rehabilitation

Required to take, transport, and/or temporarily possess sick, injured, and orphaned migratory birds for rehabilitation purposes. (4)

• Fee: \$50

- Good for up to 5 years
- 60 days + Review time
- Application
- Form 3-200-10b
- Annual Reports
- Form 3-202-4

General Public

- Good Samaritan Provision (50 CFR 21.31(a)) will allow the public who finds an injured, sick, or orphaned migratory bird to possess the bird for immediate transport to a permitted rehabilitator.
 Within 24 bours of
- permitted rehabilitator. • Within 24 hours of possession • If this are volunteers who are regularly transporting birds should be listed as a subpermittee or possess their own permit.

AL Wildlife Rehabilitation (6)

• Who can possess native wildlife?

Without exemption, a Wildlife Rehabilitation Permit is required before anyone may possess most species of sick, injured, or orphaned native wildlife for the purposes of rehabilitation; this includes well-meaning citizens, veterinarians, animal control agents, local government employees such as fire and rescue personnel, police, and those associated with "humane" or animal service organizations.

Rehabilitation of rabies vector species is NOT allowed in AL.

• Raccoons, Foxes, Skunks, Coyotes, Bats Non-protected wildlife species (Check Species!!)

 Snakes (some species), rats, mice, turtles (some species), exotic birds,

Permit Requirements (7)

- Application and Release of Liability
- Must be an AL Resident, 19 + years of age Legal US resident
- · Proof of Tetanus Vaccination within last 10 years
- \$75 application fee
- Take and pass with 80% a written examination Letter of Support from Licensed Veterinarian in AL
- Letter from County Commission or City Council wildlife not prohibited on property by local laws/ordinances.
- Proof of Facilities

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Permit Conditions

2) No person shall keep, hold, or possess in captivity for the purposes of rehabilitation any live orphaned, ill, or injured wildlife, without first obtaining a Wildlife Rehabilitation Permit for that species from the Director or his designee. Subpermittees are not allowed for any wildlife.

3) Permittee may capture, receive, possess, care for, and transport designated wildlife species within the state of Alabama for the purposes of rehabilitation, release into the wild, or euthanasia. Permittee may transfer designated species to another current Alabama Wildlife Rehabilitation Permit holder who is permitted for the species to be transferred. No wildlife may be accepted from or transferred to other states. To request an exception for specific migratory birds, email request to: <u>donr.wildliferehabilitation@donr.alabama.gov</u>.

5) A Wildlife Rehabilitation Permit grants temporary possession of wildlife for rehabilitation purposes only, not ownership or use for any other activities. Wildlife does not become private property of the permittee.

8) The Division may, upon written correspondence to permittee, temporarily or permanently suspend or prohibit the possession and rehabilitation of designated species in the event of disease or other occasion in the interest of public or wildlife health, or other reasons at the discretion of the Division.

Permit Conditions

- Enclosures Minimum Standards 4th Edition
- Inspections At any time
- Must work with a licensed AL Veterinarian.
 DCNR does NOT pay for rehabilitation or damages that may be incurred during these activities.
- Animals can only be cared for ONSITE!
- 180 days

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- Any animal that is suspected or confirmed disease must be reported to the Division immediately
- Comply with reporting requirements Monthly, yearly etc. Must notify Division within 12 hours of admission of bald or golden eagle.
- Release
 Landowner permission

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Euthanasia

- 21) Euthanasia requirements:

 With the exception of migratory birds as allowed by USFWS, non-releasable animals may not be retained by permittee or placed into other permanent captivity and must be cuthanized.
 Animals that are deemed likely non-releasable upon intake should be immediately euthanized.
 Euthanasia performed must in accordance with techniques sportved by the American Medical Veterinary Association or the National Wildlife Rehabilitator's Association.
 Permittee may not euthanize animals that are endangered, threatend, or listed in Nongame Species Regulation 220-2-92 unless medically necessary.
 Euthanasis is required for all animals with any of the following characteristics:

 Poor prognosis for release.
 Imprinted on humans, except migratory birds listed in 50 CFR 10.13.
 Blindness in both eyes.
 Unable to assume normal body postures for an extended period of time.
 Unable to assume normal body postures for an extended period of time.
 Experiencing excessive stress while in captivity or because of rehabilitation activities.

 Animals deemed to be non-releasable and poor candidates for permanent captivity by the Division or that the Division considers to be experiencing excessive stress or saffering must be euthanized.

Veterinarians

- Migratory Birds Refer to USFWS Regulations
- Mammals, reptiles, and amphibians:
 - No allowance for Veterinarians to possess wildlife without a permit.
 It is not within the law and can be found in violation.
 - No stabilization period allowed, or reporting stipulated for non-bird wildlife as the activity is prohibited.
 - Should not advertise taking in wildlife for euthanasia or stabilization.
 - Providing humane euthanasia when appropriate, the Division understands you are providing this service for a suffering animal and takes this into consideration.

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Veterinarians

- Unlawful Possession scenarios:
- "Pet" raccoon, deer or other species requiring permitting brought into the veterinary clinic for vaccinations, treatment, or surgery....you can be found to be in unlawful possession and can acquire a citation.
- Euthanasia of rabies vector species (Raccoon, skunk, bat, fox, or coyote) veterinarian can be subject to a civil action and liability even if an officer finds it was an appropriate disposition.
 - Remember to follow exposure protocols if someone brings a rabies vector species in.

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Code of Alabama, Title 34, Chapter 29 (8)

• Section 34-29-130

- Euthanize wildlife for federally licensed wildlife rehabilitation centers which are in their lawful possession.
- Federally licensed wildlife rehabilitation center can apply to purchase, possess, and use sodium pentobarbital and sodium pentobarbital with lidocaine for euthanasia purposes.

Resources

- 1. MBTA of 1918. https://www.fws.gov/law/migratory-bird-treaty-act-1918
- 2. Migratory Bird Permits. https://www.ecfr.gov/current/title-50/part-21
- USFWS Permit Types <u>https://www.fws.gov/program/migratory-bird-permit/permit-types-and-forms</u>
- Migratory Bird Rehabilitation <u>3-200-10b Migratory Bird Rehabilitation</u> (servicenowservices.com)
- (servicenowservices.com)
 Migratory Bird Permits Licensed Veterinarians. https://www.ecfr.gou/current/title-50/chapter-l/subchapter-B/part-21ep-21.2/6(v3/kiii)
 Alabama Regulations 2022-2023 Game, Fish, Furbearers and Other Wildlife. Title 9 Code of Alabama. DIVISION OF WILDLIFE AND FRESHWATER FISHERIES (outdooralabama.com)
 Wildlife Rehabilitation Permit Application and Release of Liability. https://www.outdooralabama.com/sites/default/filesAvildlife%20Rehab/Wildlife%20 Rehabilitation%20APPL/CATION%202022.pdf

- Code of Alabama 1975
 http://alisondb.legislature.state.al.us/alison/CodeOfAlabama/1975/Coatoc.htm

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Regulations

- Lacey Act, <u>18U.S.C. 42</u>.
- Lacey Act Amendments of 1981, <u>16 U.S.C. 3371–3378</u>.
- Migratory Bird Treaty Act, <u>16 U.S.C. 703–712</u>.
- Bald and Golden Eagle Protection Act, <u>16 U.S.C. 668a-668d</u>.
- Endangered Species Act of 1973, <u>16 U.S.C. 1531–1543</u>.
- Tariff Classification Act of 1962, <u>19 U.S.C. 1202</u>, [Schedule 1, Part 15D, Headnote 2(d), T.S.U.S.].
- Fish and Wildlife Act of 1956, <u>16 U.S.C. 742a-742j-</u>I.
- Marine Mammal Protection Act of 1972, <u>16 U.S.C. 1361–1384</u>, <u>1401–1407</u>.
- Title 50 Part 10.13 List of Migratory Bird Species Protected by the MBTA <u>eCFR:: 50 CFR 10.13 -- List of</u>
- Birds Protected by the Migratory Bird Treaty Act. Code of Alabama Code Of Alabama (state.al.us)
- Alabama Regulations 2022-2023 Game, Fish, Furbearers and Other Wildlife. Title 9 Code of Alabama DIVISION OF WILDLIFE AND FRESHWATER FISHERIES (outdooralabama.com)
Questions?

Stephanie Kadletz MNR, CWR, CET Assistant Director, Raptor Rehabilitation Auburn University Raptor Center sak0050@auburn.edu 334-539-2262



From Parrots to Peregrines Initial Triage & Stabilization of Birds

Amberly Sokoloff, VMD

Auburn University Raptor Center

Outline

- Phone triage
- History
- Observation in carrier
- Sedation options
- Physical exam
- Hydration assessment
- Fluid administration
- Pain assessment
- Analgesia options
- Common presentations
- Diagnostics

Handling Phone Calls

- Staff training
 - Make sure potential emergency cases are not dismissed
 - ANY sign of illness in birds is usually an emergency PREY species try to mask illness
 - Allow sufficient time for appointments
 - Ask client to bring pet's food

What is an Emergency

- On the bottom of the cage, falling off perch
- ► Tail bobbing, open beak breathing, wheezing
- Bleeding
- Seizure
- Possible fracture
- Straining to pass an egg
- Not eating or drinking for >8hr
- Regurgitation (non-behavioral), diarrhea
- Any encounter with a predator, particularly cats

Handling Phone Calls - Wildlife

- Make sure to emphasize rescuer safety
- Use gloves, blankets, towels
- Place in a carrier or box with ventilation holes
- ► Keep in dark, quiet area, avoid temperature extremes

What is an Emergency - Wild Birds

- Any bird older than fledgling that is not flying away from you
- Any bird with a known cat interaction scratch, bite, in the cat's mouth, whether or not wounds are found
- Proximity to a domestic animal is not an emergency
- Give staff resources to educate the public about when to leave wildlife alone

Wildlife - Veterinarian's Role

- Mammals, reptiles, amphibians
 - Federal government only involved if threatened or endangered species
 - State law prohibits possession without a permit, no allowance for veterinarians
 - DCNR Officers use discretion in instances where humane euthanasia is appropriate to relieve suffering in wildlife
 - May not advertise that this is a service you provide
 - May not provide care to a client in unlawful possession of wildlife as a "pet" must go to a licensed rehabilitator or facility

Wildlife - Veterinarian's Role

Euthanasia of Rabies Vector Species

If you choose to assist with euthanasia of a raccoon, skunk, bat, fox, or coyote, you may be subject to civil action and liability if the finder later decides to undergo treatment for potential rabies exposure and protocols for disease exposure and testing were not followed

Contact public health department

Wildlife - Veterinarian's Role

- Become a permitted wildlife rehabilitator
 - Alabama Department of Conservation and Natural Resources, Wildlife and Freshwater Fisheries Division
 - Marianne Gauldin, Outreach Specialist: marianne.gauldin@dcnr.alabama.gov
 - www.outdooralabama.com
 - ▶ \rightarrow Wildlife \rightarrow Wildlife Rehabilitation
 - ▶ List of current rehabilitators, information on becoming a rehabilitator, FAQs

Wildlife -Veterinarian's Role

- Code of Federal Regulations, Title 50, Part 21 - Migratory Bird Permits
- Allowed to treat and stabilize, must transfer within 24 hours once stable
- Allowed to euthanize if sick or injured

• Subpart B—Exceptions to Permit Requirements

Source: 39 FR 1178, Jan. 4, 1974, as amended at 87 FR 880, Jan. 7, 2022.

• § 21.12 General exceptions to permit requirements.

The following persons or entities under the following conditions are exempt from the permit requirements:

- (c) *Licensed veterinarians:* Licensed veterinarians are not required to obtain a Federal migratory bird permit to temporarily possess, stabilize, or euthanize sick and injured migratory birds. However, a veterinarian without a migratory bird rehabilitation permit must transfer any such bird to a federally permitted migratory bird rehabilitator within 24 hours after the bird's condition is stabilized, unless the bird is euthanized. If a veterinarian is unable to locate a permitted rehabilitator within that time, the veterinarian must contact his or her Regional Migratory Bird Permit Office for assistance in locating a permitted migratory bird rehabilitator and/or to obtain authorization to continue to hold the bird. In addition, veterinarians must:
 - Notify the local U.S. Fish and Wildlife Service Ecological Services Office immediately upon receiving a threatened or endangered migratory bird species. Contact information for Ecological Services offices can be located on the Internet at http://offices.fws.gov;
 - (2) Euthanize migratory birds as required by § 21.76(e)(4)(iii) and § 21.76(e)(4)(iv), and dispose of dead migratory birds in accordance with § 21.76(e)(4)(vi); and
 - (3) Keep records for 5 years of all migratory birds that die while in their care, including those they euthanize. The records must include: the species of bird, the type of injury, the date of acquisition, the date of death, and whether the bird was euthanized.

History & Husbandry

- Use forms to make sure important information is not missed
- https://media.wiley.com/product_ancillary/31/11191492/DOWNLOAD/Histor y%20Forms_EAECCM%20Textbook%202021.pdf
- Housing cage, substrate, toys
- Diet
- Enrichment
- Toxin exposure
- Changes in appetite, activity, urination, defecation, reproductive behavior
- Have owner fill out online form at home, in waiting room, or while you triage and perform initial assessment

Technicians

- Training in handling and observation is critical
- Participate in or at least observe any treatments or procedures until you are sure that your nursing staff is comfortable working with these species
- Fear Free Avian

Triage

- Minimize handling
- If patient appears stable, have technician take history but not collect vitals
- If patient is not stable, have technician bring to treatment area for immediate assessment
- Restraint is stressful, catecholamine release is not your friend

Patient Observation - In Carrier

- Attitude
- Posture
- Respiratory rate & effort
- Appetite
- Feather quality
- Body condition
- Hydration status
- Neurologic status
 - Posture
 - Ambulation
 - ► Flight
- Droppings



Immediate Supportive Care if Unstable

- Place bird in oxygen cage
- Provide heat support ~85°F
- Provide humidity
- Determine if bird is stable enough for PE
 - If very debilitated or in respiratory distress warn owner that stress of restraint could result in death

Sedation

- Very helpful in stressed patients
- Many drugs can be given IM or intranasal (IN)
- Midazolam 2-3mg/kg (IM, IN, IV, SC)
 - Higher doses in smaller birds (4-8mg/kg)
- Midazolam 1-3mg/kg + Butorphanol 1-3mg/kg (IM, IN, IV, SC)
 - Higher doses in smaller birds
 - Lower doses in compromised patients
- Midazolam 1-3mg/kg + Dexmedetomidine 0.01-0.04mg/kg (IM, IN, IV, SC)
 - Raptors: Midazolam 2mg/kg + Dexmed 0.01-0.02mg/kg

Sedation - Reversal

- Flumazenil 0.04-0.05mg/kg (IM, IN, IV, IO)
 - > Typically give unless sedated for bandage placement, E-collar, bleeding, or tx for seizures
 - May need to give a second dose in cockatoos
 - May see self-limiting regurgitation in macaws
- Naloxone 0.04mg/kg (IM, IN, IV, IO)
 - Not usually needed
- Atipamezole equal volume to dexmedetomidine

Physical Exam

- Have all equipment ready before you pick up the bird
- Room should be small with doors and windows closed and no other animals present
- May only be able to examine for a minute at a time, placing back in oxygen in between
 - Prioritize systems of most concern

Physical Examination

- Hold bird upright
- Check crop for presence of food/fluid
- Body condition
- Auscultation
- Coelomic palpation
- Oral examination
- Limbs, check ulnar vein







Red Tailed Hawk (Buteo jamaicensis)

Auscultation

- Infant stethoscope
- Takes practice to count HR>300
 - Count in groups of 10 for 6 seconds
- Listen on both sides of the keel for heart and air sac breath sounds
- Listen over the back for lung sounds
- Physiologic murmurs due to significant dehydration and/or anemia
- Cardiovascular disease common in older parrots, but typically auscultation is normal





Radiology of Birds, Silverman & Tell, 2010

Practical applications of fluorescence photobiomodulation in skin cases

Amelia G. White, DVM, MS, DACVD[®] Associate Clinical Professor, Dermatology Auburn University College of Veterinary Medicine

Pathomechanisms of Photobiomodulation

Cellular Pathomechanism of PBM





Cios, A., et al. Effect of Different Wavelengths of Laser Irradiation on the Skin Cells. Int. J. Mol. Sci. 2021, 22, 2437. https://doi.org/10.3390/ijms22052437

What is Phovia?



What is Phovia?

HEALING WITH THE SPEED OF LIGHT

Phovia is a dermatology system clinically proven to accelerate healing for skin lesions and **visibly reduce recovery time by 50%** through the use of fluorescent light therapy







The chromophore gel is applied to the lesion, and illuminated with a multi-LED Lamp.

FLE provides a broad spectrum of wavelengths capable of penetrating skin at different depths.



Phovia[™] – Fluorescent Light Therapy



Phovia[™] – Fluorescent Light Therapy



Phovia[™] – Fluorescent Light Therapy



• Steps

- 1. Shave hair
- 2. Clean with chlorhexidine and saline
- 3. Mix carrier gel with chromophore gel immediately before application
- 4. Apply gel 2mm layer
- 5. Illumination #1 (2 min, <5 cm from lesion)
- 6. Wipe off gel with saline gauze
- 7. Illumination #2 (2 min)
- 8. Wipe of gel and done!
- At home care:
 - •+/- topical or systemic therapies as planned
 - Healing time reduced 50% with Phovia[™] and SOC treatment

•Monitor for redness, irritation, swelling or pain

Superficial Pyoderma

8 yo MC American Eskimo



10 yo FS Yorkshire Terrier



Day 0

Day 14
4 yo FS terrier mix



4 yo FS terrier mix



4 yo FS terrier mix



4 yo FS terrier mix – 1 week later



1 yo FS dachshund mix



Time (in weeks) to clinical resolution

Canine superficial pyoderma

Marchegiani et al., 2018



*All dogs underwent culture and sensitivity swab sampling at the time of enrolment



Mucocutaneous Pyoderma

Myles – Mucocutaneous Pyoderma

- 7-year-old MC Welsh corgi
- 7-month history of drooling and perioral dermatitis
 - Pruritic perioral only
- No previous skin problems
- Severe dental disease
 - Gingivitis, tartar, tooth fractures
- Previous treatments
 - Topical antiseptic, cefpodoxime, marbofloxacin, steroids, NSAIDs



Myles- Mucocutaneous Pyoderma



Myles- MCP, 1 week later

Phovia, mometasone 0.1%, mupirocin



Deep Pyoderma Chronic Decubital Ulcers

12 yo M Labrador Retriever











Day 0







Day 14

Day 14 – after removing gel

Phovia™ – Fluorescent Light Therapy



Day 28

Day 35



Day 42

2 weeks after last Phovia[™]





1 year later



Decubital Ulcer



5 days later

FIGURE 1. Time (weeks) to clinical resolution



Canine deep pyoderma

Marchegiani et al., 2017 & 2021



Acral Lick Granulomas Acute and Chronic









PHOVIA



Acral Lick Dermatitis



Day 0

Day 45

Acral Lick Granuloma



Day 0

Day 35 – 3 Phovia Tx

Day 45 – 6 Phovia Tx

Day 60

Pedal Furunculosis

10 y/o MC Jack Russell Terrier





Day 0

Day 21









Canine interdigital furunculosis

Marchegiani et al., 2019



Figure 1. Percentage of dogs healed by treatment and study week. *P-value based on two-sided Fisher's Exact test.

Canine interdigital furunculosis

Marchegiani et al., 2020



Acute Wounds

3 yo MC GSP





Visit 2 – Day 7



Visit 3 - Day 24





Visit 4 – Day 30


Surgical Wounds











1 week

2 weeks

3 weeks

4 weeks

Wound dehiscence



@KarlyHRobinson

Surgical Wounds Salvaggio et al., 2020

FIGURE 1. Histologic appereance of wounds



Surgical Wounds Salvaggio et al., 2020





Anal Sacculitis and Rupture

Wounds - anal sacculitis and rupture





Wounds - anal sacculitis and rupture



Wounds - anal sacculitis and rupture



Perianal Fistulae

Perianal Fistulas

1 week later

Canine perianal fistulae

Marchegiani et al., 2020





Figure 5. Median weekly scores for dyschezia (vocalization, straining) and discomfort (licking) in German shepherd dogs with perianal fistulae treated with fluorescence light energy.

A statistically significant improvement was seen starting from Week



Burns





Burns



Burns - Ferret







Avian Wound - Electrocution



Avian Wound - Electrocution







Day 0

Day 5

Day 7

Chronic Wounds

Equine Wounds



Week 1

Week 2

Week 3

Week 5

Avian Infections & Wounds



Avian Infections & Wounds



1st Phovia treatment



Avian Infections & Wounds



1 week

2 weeks

4 weeks





Other Applications

- Bacterial pyoderma
 - Surface
 - Superficial
 - Deep
- Pinnal dermatitis
- Perianal fistulas
- Surgical wounds
 - Complicated
 - Uncomplicated
- Traumatic wounds
 - Burns
 - De-gloving injuries
 - Road rash

FLE Limitations

- Neoplasia?
 - Accelerate mitochondrial activity affects on neoplastic cell activity?
- Still need to ID and treat the primary disease
 - Allergy, endocrinopathy, trauma, etc.
- Not a miracle cure!
 - Combine with SOC treatments for better outcomes
- Design treatment protocols that fit the condition
 - Chronic acral lick granuloma vs acute wounds



Questions?

Cardiac Emergencies: How You and Your Patient can Survive Using Practical Advice

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Abstract

This presentation is intended to describe the typical presentation of several different types of cardiac emergencies in dogs and cats, and materials used will include case information such as ECGs, thoracic radiographs, and echocardiography. Diagnosis and therapeutic intervention will be reviewed, focusing on a practical way to approach these cases. Topics covered will include congestive heart failure, pericardial effusion, and feline arterial thromboembolism.

Keywords: heart failure, pericardial effusion, thromboembolism

Congestive Heart Failure

Dogs with congestive heart failure (CHF) will likely have either myxomatous mitral valve disease (MMVD) or dilated cardiomyopathy (DCM), as these are the most common acquired diseases in the dog. The criteria to diagnose left-sided CHF are the same, regardless of disease, namely: acute onset of coughing/respiratory signs (1-2 days), caudodorsal/perihilar interstitial to

alveolar pulmonary pathology, pulmonary venous distention, and an enlarged left heart (LA and LV, which is easier to appreciate in small breed dogs, but harder to discern in large breeds like Dobermans).¹ Disease severity and amount of pulmonary edema dictate how aggressive therapy needs to be. I have generally less concern about severity if a dog presents with: resp rate $\sim 40 - 80$ bpm; has mild to moderate interstitial pattern; has focal / multifocal distribution on rads. I have generally more concern about severity if a dog presents with: resp rate > 80 bpm; severe interstitial pattern; mild to moderate alveolar pattern; large areas of the lungs affected; outstretched neck; or red frothy nasal discharge.

Treatment approach should be similar, but tailored to disease severity / your concern as a clinician. Dogs should receive a FONSP approach: Furosemide, Oxygen, Nitroprusside (+/-), Sedation, and Pimobendan. Most of the changes in treatment are in furosemide dose. For cases with less concern, generally a total of 8-12 mg/kg in 24hrs is needed. For cases with more concern, generally a total of 14 – 24 mg/kg in 24hrs is needed. Other things to do include: butorphanol 0.2 mg/kg SQ/IM/IV; nitroprusside paste inner pinna (if you have it - this works for some dogs, but does not work for all dogs); 40-60% oxygen cage if available; 0.5 mg/kg pimobendan PO if able (above-label dose helps more in beginning, be sure to follow with a few drops of water to encourage swallow). My goal for the first 12-18 hrs is to decrease the RR by 50% (or less than 40 bpm). Once RR < 40 bpm, back off Lasix (q8h dosing, stop CRI). Dobermans (or other large breed dogs) with CHF due to DCM may need a CRI of dobutamine (~2-10 mcg/kg/min) additionally. Cats rarely need more than ~5-7 mg/kg furosemide over an 18-24 hr period to clear their edema (FONS-T, where 'T' is for thoracocentesis if pleural effusion is present - Remember: Lasix prevents further accumulation of fluid – it won't do anything to pleural effusion already present. Therefore, you have to physically remove if present).

Feline Arterial Thromboembolism

Feline arterial thromboembolism (FATE) is a severe disease syndrome, but even this can be managed successfully. Like many other diseases we treat, the client communication aspect of management is a very important consideration. Recognizing FATE as soon as possible and understanding how to move forward through the case is paramount. A common history includes: acute onset (i.e. just found like that); vomiting min to hours prior (~15%); no previous dx of cardiac disease (very common). A common physical examination includes: cold, pulseless, pale limbs and toe pads; initially painful and contracted muscles; lower motor neuron signs. The sites of thromboembolism may be: "saddle" i.e. both rear limbs (75% of cases); one rear limb (10% of cases); right fore limb (10% of cases); and possibly the renal, mesenteric, or cerebral arteries. The underlying etiology is most often left atrial enlargement (any cardiomyopathy), but can also be from hyperthyroidism or a pulmonary mass

Diagnostics that may be helpful include: thoracic radiographs to rule out CHF (ONLY IF STABLE ENOUGH); echocardiography (ONLY IF STABLE ENOUGH); blood chemistry panel (most interested in BUN, CREA, CK, AST, Electrolytes); or you could use NOVAs paired – central vs. affected limb (affected limb glucose lower and lactate higher). Prognostic information to tell the owner should include both short-term and long-term information. In the short-term: ~50% survive to discharge; often ~72 hours of treatment needed (2-5 days); cats will go home with motor impairments. In the long-term: it may take 4-6 weeks to fully regain motor function; unless this was caused by uncontrolled hyperthyroidism, it is not "fixable"; if this was caused by a cardiac etiology, it will happen again (6 hrs, 6 days, 6 months – no way to know for sure). Some prognostic factors to keep in mind include: any motion function is good; unilateral limb better than bilaterally affected; rectal temperature (hypothermia of less than 99° F at intake

has a less than 50% chance of survival); and heart rate (cats presenting with bradycardia of 150 bpm or less have a worse prognosis).

The initial treatment should include: Lasix 1 mg/kg IM/IV (even if thoracic radiographs have not been taken, and therefore the definitive diagnosis of pulmonary edema has not yet been made); pain meds (Methadone 0.6 mg/kg IV q4-6h or Fentanyl 3-5 mcg/kg IV bolus and then 2-5 mcg/kg/h CRI (Buprenorphine likely insufficient for this amount of pain); and an anticoagulant. I recommended giving Clopidogrel 75 mg tab PO once, and then decreasing to the standard dosing afterwards. In addition to clopidogrel, an additional anti-coagulant is needed concurrently, such as: Apixaban 0.2 mg/kg PO BID; Low molecular weight heparin (Dalteparin 200 units SQ BID); Aspirin 81 mg PO q72h (efficacy is questionable, and it risks GI side effects. If heart failure is also diagnosed, then administration of the following is recommended: Lasix 1-2 mg/kg q6h (usually only need 4-7 mg/kg over 24 hours); supplemental oxygen; and NO FLUIDS. If there is not heart failure present, then IV fluids may be helpful to help restore perfusion and balance electrolyte concentrations. Methadone / fentanyl is needed for ~48hrs, and then you can decrease to buprenorphine 0.2 mg/kg q6-8h.

In-hospital monitoring should include: NOVA/biochemistry analysis q 6-12 h (hyperkalemia may develop with reperfusion and is sometimes fatal) and an ECG q 6 h. The ECG is especially useful if you are unable to get frequent blood samples, as we are monitoring for hyperkalemic ECG changes including bradycardia, QRS widening, tall T-wave, and ST depression. Supportive care is an important aspect to provide and should not be overlooked. These cats with motor deficiencies may need help with accessing the litter box. They may need towels to keep warm (heating pads may burn ischemic skin easily). They may also need to have passive range of motion performed (especially if any motor present / returns). The long-term outlook was

described by the FATCAT study.² That study described a 443 day median survival after the first thromboembolism when given clopidogrel, with endpoints including the second thromboembolic event or death. Once a cat has heart failure, they may have another 2-3 years of life left. Frequent rechecks (q 1 - 3 months) are recommended.

Pericardial Effusion

Pericardial effusion is a common cardiac emergency in canine medicine. There is a long list of differential diagnoses for the underlying etiology of pericardial effusion in the dog, including: cardiac neoplasia, idiopathic effusion, right sided heart failure, left atrial rupture, pericardial cyst, pericardio-peritoneal diaphragmatic hernia, pericarditis, anticoagulant overdose, and an infectious etiology. However, the most common etiologies are neoplastic and idiopathic. Together these 2 disease entities comprises ~80% of all cases of pericardial effusion in the dog. Roughly 60% of these cases are neoplastic in origin, the two most common types including hemangiosarcoma and chemodectoma.

References

1. DeFrancesco TC. Management of cardiac emergencies in small animals. Vet Clin Small Anim 2013;43:817-42.

2. Hogan DF, Fox PR, Jacob K, et al. Secondary prevention of cardiogenic arterial thromboembolism in the cat: the double-blind, randomized, positive-controlled feline arterial thromboembolism; clopidogrel vs. aspirin trial (FAT CAT). J Vet Cardiol 2015;17:S306-17.

Cardiac Examination: Relying on More than Just your Stethoscope

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Abstract

This presentation is intended to describe the methods and procedures for performing a complete cardiac examination, focusing on the non-auscultation aspects of the examination. Diagnosis of cardiac diseases will be covered, using ECG, patient images, and echocardiographic images. The presentation will describe aspects of abnormal cardiac examinations and describe the physiologic mechanisms that account for the findings.

Keywords: auscultation, jugular pulsation, thrill

Body Condition & Muscle Mass

Body condition scoring (BCS) is a commonly performed assessment in the routine physical examination of veterinary patients. This utilizes details about overall conditioning, such as ability to see / palpate ribs and dorsal processes of the spine, and more specific evaluations of muscle mass can be incorporated in these scores. Almost any chronic disease can cause poor body condition and progressive weight loss, and this is referred to as cardiac cachexia when caused by a chronic cardiac disease (congenital and acquired).

Although little diagnostic information is gained by observing that a dog or cat has poor body condition (i.e. it could be caused by a cardiac disease, or a systemic disease, etc.), this is an important aspect to the non-auscultation cardiac examination for the following reasons: 1) Some clinical signs such as lethargy, generalized weakness, or collapse can be explained by poor muscle mass that develops with cardiac cachexia. With this in mind, it may be of benefit to identify "at risk" patients (those with chronic cardiac diseases that are just beginning to lose weight and muscle mass) and recommend diet changes to prevent further decline.

2) Dogs and cats with congestive heart failure (CHF) have worse survival times when they present in CHF in poor body condition (BCS 4/9 or less) compared to dogs and cats with good (BCS 5/9) or obese (BCS > 5/9) body conditions. Knowing that animals with chronic heart disease have poor survivals if thin and may lose weight and muscle mass over time due to cardiac cachexia, it is important to prevent this loss as much as possible prior to the onset of CHF.

Mucous Membranes

Assessment of mucous membranes is an important part of all physical examinations. Although many diseases / conditions produce alterations in mucous membranes (i.e. many non-cardiac), this section will only discuss those that have relevance to cardiologic diseases.

1) Pale mucous membranes: This finding can be observed with anemia, as the percentage of red blood cells within the blood decreases (and so plasma percentage increases) which causes a pale coloration. Cardiac arrhythmias that decrease cardiac output (both tachyarrhythmias and bradyarrhythmias may decrease cardiac output) which therefore decrease perfusion to the blood vessels within the mucous membranes. Arrhythmia-induced pale mucous membranes are typically episodic and seen most commonly with very fast tachyarrhythmias (ventricular
tachycardias or supraventricular tachycardias with heart rates ~ 250 bpm or greater) or with bradyarrhythmias that have long pauses with no heart beats (such as with Sick Sinus Syndrome, when dogs may have no heart beats over a period of 6-12 seconds). Once the heart rate is normal again, the mucous membranes will be normal pink color again. This finding of transient pale mucous membranes should warrant investigation for an arrhythmia.

2) Tacky mucous membranes: This finding of dry mucous membranes is observed with many different diseases, but can indicate dehydration. Some dogs pant often while in the veterinary hospital, and this will cause the gums to be dry but may just affect this local environment (i.e. the dog may not be dehydrated, even though the panting has caused temporary tacky mucous membranes).

3) Hyperemic mucous membranes: This finding of dark red mucous membranes is observed with an increased hematocrit causing an increased percentage of red blood cells within the blood. Some dogs with right-to-left shunts develop polycythemia. The poorly oxygenated blood that gets into the systemic circulation interacts with the kidneys. This oxygen-poor blood stimulates the kidneys to release erythropoietin, which causes the bone marrow to produce more red blood cells. When hematocrits are very high (~65% or greater), the blood is too viscous to properly perfuse tissues and clinical signs such as collapse may develop. At this point, red blood cells need to be removed with therapeutic phlebotomy.

4) Cyanotic mucous membranes: This finding of blue/purple mucous membranes is observed with central cyanosis and differential cyanosis. Central cyanosis is when the entire systemic blood pool is poorly oxygenated. This may be observed with an intra-cardiac right-to-left shunt (i.e. ventricular septal defect, atrial septal defect, or Tetralogy of Fallot) or hypoxia (i.e. pulmonary thromboembolism causing pulmonary hypertension, or lack of adequate O₂ intake such as when choking, with tracheal collapse, or when an endotracheal tube is inadvertently placed in the esophagus). Differential cyanosis describes when mucous membranes in the cranial half of the body are normal and pink colored, whereas mucous membranes in the caudal half of the body are cyanotic. This typically happens with a right-to-left shunt outside of the heart, typically with a right-to-left shunting patent ductus arteriosus. Some dogs are born with shunts such as a ventricular septal defect, atrial septal defect, or a patent ductus arteriosus that allow blood to move from left heart chambers (or systemic circulation) into the right heart chambers (or pulmonary circulation). Over time if the volume overload is significant, the pulmonary arteries reflexively vasoconstrict and this arterial endothelium and vascular smooth muscle develops pathologic changes with chronicity. These changes begin to increase the pulmonary arterial pressure (i.e. cause progressive pulmonary hypertension), and this process may continue until the pulmonary pressures are greater than the systemic pressures. Right heart pressures correlate with pulmonary arterial pressures. Once this occurs, blood moves from the right side of the heart (or pulmonary circulation) into the left heart chambers (or systemic circulation). Thus, what was originally a left-to-right shunt became a right-to-left shunt due to the development of severe (supra-systemic) pulmonary hypertension. This process is called Eisenmenger's Syndrome.

Femoral Pulse Evaluation

Evaluating the femoral pulses is a critical aspect to the cardiovascular examination. This should be performed while simultaneously auscultating the animal's heart (if small animal). There are several details to hone in on during femoral pulse assessment:

1) Femoral pulse strength: The pulse pressure is defined by the following formula:

Pulse Pressure = Systolic Pressure – Diastolic Pressure

The larger the quantity for pulse pressure, the stronger the pulse will feel during palpation. Diseases with reduced forward cardiac output (such as Dilated Cardiomyopathy, or Subaortic stenosis) will have a reduced systolic pressure, so the pulse pressure will be diminished (i.e. weak pulse). Diseases with a reduced diastolic pressure (such as left-to-right shunting patent ductus arteriosus or severe aortic regurgitation) will have a greater pulse pressure assuming systolic pressure does not change (i.e. hyperdynamic pulse).

2) Are femoral pulses synchronous with heartbeats? Each heartbeat should generate a femoral pulse. By simultaneously palpating femoral pulses and auscultating the heart, one can easily discern if a heartbeat occurs without a concurrent femoral pulse (i.e. "missed pulse" or drastically weakened pulse for one heartbeat). This may occur with premature heartbeats, both ventricular and supraventricular in origin. The premature timing of the beat causes a shortened diastolic filling time of the ventricles, which has reduced cardiac output for that beat.

Cardiac Impulse Palpation

In a normal dog, the cardiac impulse should be almost exclusively appreciated on the left hemithorax. The left ventricle of a normal dog has much more muscle mass than the right ventricle, and so it is easier to feel the heart beat on the wall of the left hemithorax compared to the right. While palpating both sides of the chest simultaneously, the impulse on the right hemithorax may not even be appreciated in a dog with a normal right ventricular size. When a dog develops right heart enlargement (either eccentric or concentric hypertrophy), the cardiac impulse on the right hemithorax can become as strong or stronger than the impulse on the left hemithorax. Note: while palpating for the cardiac impulse, you can also appreciate whether or not there is a cardiac thrill (i.e. 5/6 murmur).

Jugular Vein Assessment

Observing for jugular venous distention and / or pulsation should be a routine part of every physical examination, or at the very least in patients with a suspicion of cardiac disease. The external jugular vein can be observed from the manubrium to its bifurcation into the linguofacial and maxillary veins. Normal dogs may have some pulsation of the jugular vein near the manubrium (no more than $\sim 1/3$ of the distance starting at the manubrium and ending at the bifurcation). Dogs with elevated right atrial pressure may have distention / pulsation observed more than $\sim 1/2$ this distance up towards the bifurcation of the jugular vein. The course of the right jugular vein has direct connection to the cranial vena cava, aligned in a straight line; however, the left jugular vein has a more curved connection to the cranial vena cava. This likely makes the translation of pressure from the right atrium / cranial vena cava easier to observe on the right jugular vein (i.e. it is easier to observe a dilated / pulsating jugular vein by observing the right external jugular vein).

Hepatojugular Reflux Test: This test is performed in combination with the jugular venous assessment. While observing the right external jugular vein, apply pressure to the cranial abdomen with a closed hand. Maintain this pressure during visual inspection of the jugular vein. By applying pressure to the cranial abdomen, the liver is somewhat compressed causing extra blood volume to travel from the liver into the right heart via the caudal vena cava. In dogs with normal right heart pressures, this extra blood volume will enter the right atrium and then right ventricle. Since normally the right atrium and ventricle are relatively compliant (i.e. can expand and take in extra volume without significantly increasing the chamber pressure), this extra blood

is received and there is no change to the right jugular vein. This is a normal result, AKA a negative hepatojugular reflux test result. In dogs with abnormally elevated right heart pressures, the extra blood volume enters the right atrium but cannot all enter the right ventricle. A right ventricle in or on the verge of heart failure has lost its compliance and is already stretched to its maximum size. The extra blood volume causes an increase in right atrial pressure, so some of this extra blood volume and the pressure it causes travel to the cranial vena cava and into the external jugular vein. While compressing the liver, you will observe the right jugular vein becoming more distended. Once the compression is released, the jugular vein will become less distended. This finding suggests the presence of significant right heart disease. This is a positive result, AKA a positive hepatojugular reflux test.

References

1. Fang JC, O'Gara PT. The history and physical examination: an evidence-based approach. In: Bonow RO, Mann DL, Zipes DP, Libby P, editors. Braunwald's heart disease: a textbook of cardiovascular medicine. Philadelphia: Elsevier Saunders; 2012. p.107.

EC Gee What Do I Do Now? Case-based Discussions Part 1

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Abstract

This presentation is intended to provide case presentations of various tachyarrhythmias including information on tools to make an accurate ECG diagnosis, case stabilization and therapy, and disease prognosis. Step-by-step case management details will be provided to help practitioners understand how best to work through these and similar cases, and specifics on treatment options (both in-hospital and chronic medications) will be provided.

Keywords: arrhythmia, tachycardia, treatment

Supraventricular tachycardia

- The definition of a supraventricular tachycardia (SVT) is one that originates above the atrioventricular (AV) node, thereby using the specialized conduction system in the ventricles to achieve ventricular depolarization

- This means that the QRS complexes should be normal in duration (i.e. narrow QRS complexes)
 - ** a notable exception is when you have BOTH SVT and bundlebranch block CONCURRENTLY – this causes abnormally wide QRS complexes and many be confused with ventricular tachycardia**
- One type of SVT is atrial fibrillation
- Treatment is aimed at slowing the heart rate
 - Two types of treatment exist: 1) Rhythm control; 2) Rate control
 - Rhythm control: these therapies convert the rhythm from SVT to normal sinus rhythm
 - Amiodarone is an oral class III anti-arrhythmic that has been shown to convert SVTs such as atrial fibrillation into normal sinus rhythm
 - Usually given as a loading dose: ~10 mg/kg PO BID
 for 5 days, then ~ 5 10 mg/kg PO q24h
 - Nexterone is an injectable version of amiodarone
 - 2mg/kg IV bolus (followed with CRI 0.8mg/kg/hr for 6 hrs, and then followed by 0.4 mg/kg/hr for 18 hours)
 - Rate control: these therapies limit the function of the AV node, so that fewer supraventricular impulses traverse the AV node
 - Causes fewer ventricular depolarizations, i.e. fewer heart beats
 - Typically rate control works faster than rhythm control
 - And so is preferable in an acute emergency situation

- Diltiazem is an oral or injectable calcium channel blocker
 - \circ 0.2 mg/kg IV bolus
 - Repeat in 5 min if the heart rate is not better.
 - Then begin 0.5 mg/kg IV doses
 - repeat dosing in 5 min if no improvement
 - Should see some effect with 3-4 doses
 - Then start oral diltiazem XR ~2-3 mg/kg PO BID
- Other drugs such as beta-blockers and digoxin can be given, but each have side-effect profiles that make them less than ideal (and so I prefer diltiazem)

Ventricular tachycardia

- The definition of a ventricular tachycardia (VT) is one that originates below the AV node, thereby not using the specialized conduction system in the ventricles to achieve ventricular depolarization
 - This creates "wide and bizarre" QRS morphology
 - QRS complexes are wider than normal due to not using the specialized conduction system (impulses spread cell by cell)
 - QRS complexes do not have the "normal" pattern of the spread of depolarization, so they will look sometimes very different than the typical sinus QRS

- Treatment is given if one or both of the following conditions are met: 1) the VT is having a negative hemodynamic impact on a patient; 2) the characterization of the VT has inherent risk of sudden death
 - Usually if a patient either has low blood pressure, or is collapsing, or seems weak during the VT, we can reasonably conclude that the VT is having a negative hemodynamic impact on the patient
 - If we observe the following characteristics of a VT, then we should worry that this rhythm may be inherently life-threatening:
 - Multiform QRS complexes
 - Frequent ventricular premature complexes / VT
 - Very fast VT rate (~250 bpm or above)
 - R-on-T phenomenon
 - The vast majority of dogs with VT respond to lidocaine, so that should be your first choice
 - Lidocaine, 2 mg/kg IV bolus
 - Can be repeated multiple times
 - Sedation such as butorphanol (0.2 mg/kg) can help minimize the impact of sympathetic tone on the VT, which may help stabilize the rhythm

EC Gee What Do I Do Now? Case-based Discussions Part 2

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Abstract

This presentation is intended to provide case presentations of various bradyarrhythmias including information on tools to make an accurate ECG diagnosis, case stabilization and therapy, and disease prognosis. Step-by-step case management details will be provided to help practitioners understand how best to work through these and similar cases, and specifics on treatment options (both in-hospital and chronic medications) will be provided.

Keywords: arrhythmia, bradycardia, treatment

Types of Atrioventricular (AV) block

- First degree AV block: there is 1 to 1 AV conduction (i.e. for every P wave, there is a QRS complex), and the PR interval is abnormally prolonged
 - This does not cause any clinical signs, and so there is no direct treatment for this ECG diagnosis

- Second degree AV block, type I: the PR intervals progressively prolongate, until there is a P wave that is not followed by a QRS complex. Then, this pattern repeats. Typically only 1 P wave is not conducted at a time (i.e. there are not multiple P waves in a row that are not followed by a QRS complex)
 - This does not cause any clinical signs, and so there is no direct treatment for this ECG diagnosis
- Second degree AV block, type II: often the PR intervals are consistent from beat to beat (i.e. the PR intervals are the same), however, not all P waves are followed by a QRS complex. There is a range of severity, from 1 or 2 consecutive P waves not followed by a QRS complex, to many consecutive P waves
 - When there are more than 2 consecutive P waves that occur without being followed by a QRS complex, then this can easily cause clinical signs and should be further investigated.
- Third degree AV block: atrial depolarizations (P wave) never traverse the AV node to initiate ventricular depolarizations, and the patient's heart beats are initiated by ventricular escape beats
 - In a dog or cat, this rhythm may cause clinical signs and should be further investigated
 - Dogs may have ventricular escape rats of ~20-50 bpm
 - Cats may have escape rates (can be junctional or ventricular) of ~100-140 bpm
- ** Differentials for all types of AV block include the presence of excessive parasympathetic tone and AV nodal disease**

- Typically first degree AV block and second degree AV block type I are caused by excess parasympathetic tone
- Typically second degree AV block type II and third degree AV block are caused by AV nodal disease
- Atropine 0.04 mg/kg IV or IM can be given
 - If AV block goes away, then the AV block was originally caused by excessive parasympathetic tone
 - Body organ systems that when diseased can cause excess

parasympathetic tone systemically include:

- o Central Nervous System
- Gastrointestinal
- Respiratory
- o Ocular
- If AV block remains, then excess parasympathetic tone is not present,

and there is AV nodal disease

- Treatment for severe AV nodal disease includes pacemaker implantation
- The presence of VPCs or uncontrolled systemic hypertension are considered contraindications to atropine administration

Sick Sinus Syndrome

- Sick sinus syndrome (SSS) is a diagnosis that can have multiple ECG abnormalities including some or all of the following:

- Frequent sinus arrest
- o Persistent sinus bradycardia
- o Supraventricular tachycardia
- o AV block
- Lack of ventricular escape complexes
- If there are clinical signs related to SSS, then determination of what aspects of the ECG rhythm are responsible for the clinical signs is important
 - If there is supraventricular tachycardia causing clinical signs, then

medications such as diltiazem may be needed

- **if there is concurrent periods of AV block or sinus arrest, then the diltiazem alone may make these worse, and so concurrent pacemaker implantation may be indicated**
- If AV block, frequent sinus arrest, or persistent sinus bradycardia are responsible for the clinical signs, then pacemaker implantation is indicated