Providing the best quality care and service for the patient, the client, and the referring veterinarian.

Diagnosis and Management of Life Threatening Cardiac Emergencies

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Overview

- Diagnosis of cardiac tamponade & pericardiocentesis
- Recognition & treatment of life threatening arrhythmias (ventricular tachycardia (VT) & 3rd degree AV block)
- Treatment of refractory left-sided congestive heart failure (CHF)
- When to suspect pulmonary hypertension (PHT), diagnosis & treatment
Cardiac tamponade - recognition

- Hemodynamic unstable pericardial effusion
- Signalment
- Clinical signs
  - Acute collapse
  - Weak pulses, pulsus paradoxus
  - Poor perfusion: tachycardic, pale mm, prolonged CRT, hypotension
  - Muffled heart sounds
Cardiac tamponade - causes

- Neoplasia – hemangiosarcoma, chemodectoma, lymphoma, ectopic thyroid carcinoma, mesothioloma
- Idiopathic – middle age large breed dog
- Infectious – myocarditis
- Acute hemorrhage – rodenticide, HBC, trauma, LA rupture
Diagnosis - ECG

- Sinus tachycardia
- Low voltage QRS complexes
- Electrical alternans
Thoracic radiographs
Echocardiogram

- Inspect the heart base and right atrial appendage for tumors
- LA size in case of rupture
Echocardiogram
Treatment
Important tamponade points...

- NO lasix!!!
- Underfilled heart exasperated with furosemide
- May need IV fluids if acute
- If chronic and right-sided CHF (ascites), abdominocentesis (make sure not hemorrhagic and only modified transudate).
Arrhythmia management
Ventricular ectopy

- VPCs vs. ventricular tachycardia (VT)
  - Treatment same as VT if needed
- Underlying cardiac disease
  - Holter monitor, echocardiogram
  - Breeds – Boxers, Dobermans, GSD
  - Disease – ARVC, DCM, SAS, inherited VT
- Accelerated idioventricular rhythm
VT – when to treat

- Hemodynamic compromise
  - Cardiac disease
  - Poor pulse quality, weak, hypotensive

- Risk of degenerating into ventricular fibrillation
  - Cardiac disease – ARVC, DCM, SAS
  - Faster rates
  - Polymorphic > monomorphic
  - Repetitive forms > single forms
Acute therapy of VT

- **Lidocaine**
  - IV bolus of 1 - 2 mg/kg (up to 6 - 8 mg/kg total); then CRI (25 - 80 mcg/kg/min)
  - Positive response = rate slowed or abolished
  - Toxicity – neurologic; cats > dogs
  - May not be effective if:
    - Hypokalemia
    - Incorrect diagnosis (actual rhythm is SVT)
    - Slower rates

*All doses are canine only unless indicated otherwise*
Acute therapy of VT

- **Procainamide**
  - IV boluses of 2 - 5 mg/kg (up to 20 mg/kg total); each dose over 3 - 5 minutes
  - CRI dose 10 - 50 mcg/kg/min
  - Side effects – neurologic, esp. if lidocaine prior
  - SVT and VT

- **Magnesium**

- **Amiodarone**

- **Anesthesia and cardioversion**

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Chronic therapy

- **Sotalol**
  - 1 - 2 mg/kg PO q 12 h
  - Boxers with ARVC
  - Some beta blocking properties
- **Mexiletine**
  - 3 - 8 mg/kg PO q 8 h
  - Give with FOOD (GIT upset)
- **(Atenolol)**
  - Mildly effective, used in combination
  - Negative inotrope

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Indications:
- AV block (2nd and 3rd degree)
  - Risk of sudden death
  - Right sided CHF
- Atrial standstill
- (Sick Sinus Syndrome)
- Dual chamber, biventricular
- Advanced programming
Permanent lead implantation
ECG post pacemaker implant – atrial sensing lead
Follow up and long term care

- One month recheck, 6 - 12 months
- Jugular venipuncture CONTRAINDICATED
- Cautery – interference
- Surgery – antibiotics, heart rate setting
- Risk of infection
  - Management of endocrine diseases
  - Dog fight wounds, dental procedures, pyoderma
Treatment of refractory L-sided congestive heart failure (CHF)
Refractory L-sided CHF

- Oxygen
- Preload reduction
- Afterload reduction
- Positive inotropic support
- Arrhythmia management
- Other considerations
Oxygen

- Environmental (cage)
- Nasal prong/canulas
- Flow by
- E collar tent
Oxygen

Figure 29-4. Tracheal oxygen concentration with nasal oxygen supplementation at varying flow rates in 10 kg (diamonds) and 40 kg (squares) dogs. (Modified with permission from Fitzpatrick RK, Crowe DT: Nasal oxygen administration in dogs and cats: Experimental and clinical investigations, *JAAHA* 22:296, 1986.)
Oxygen

**Figure 29-2.** Oxygen concentration at the bifurcation of the trachea with face mask oxygen therapy at varying flow rates (diamonds) compared with flow-by oxygen 2 cm from the nose (squares). (Modified with permission from Loukopoulos P, Reynolds W: Comparative evaluation of oxygen therapy techniques in anaesthetized dogs: Face mask and flow by technique, *Aust Vet Practit* 27:34-39, 1997.)
Preload reduction (venous)

- **Furosemide**
  - IV bolus 2 - 4 mg/kg initially, repeat
  - IV CRI at 0.1 - 1 mg/kg/hr (0.5 - 1 when severe)
  - IV > IM if possible for prostaglandin release

- **Nitroglycerin**

- **Other diuretics**
  - Hydrochlorothiazide: 0.25 - 1 mg/kg PO q 24 h
  - Spironolactone: 0.5 - 2 mg/kg PO q 24 h

- (Nitroprusside)

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Afterload reduction (arterial)

- **Nitroprusside**
  - Immediate acting IV hypotensive agent (preload and afterload reduction) independent of autonomic innervation via vascular SM relaxation
  - IV CRI at 0.5 - 1 mcg/kg/min carefully titrated to effect by increasing by 1 mcg/kg/min increments every 15 minutes as long as BP remains stable (usually 2 - 5 mcg/kg/min with upper limit of 8 - 10 mcg/kg/min)
  - Concurrent use of dobutamine
  - Acidosis then cyanide poisoning > 3 days

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Afterload reduction (arterial)

- **Amlodipine**
  - Ca+2 channel blocker
  - 0.1 mg/kg q 12 - 24 h initially; titrate up as needed to 0.25 mg/kg PO q 12 - 24 h

- **Hydralazine**
  - Afterload>>>preload
  - 0.5 - 1 mg/kg PO q 12 h in patients administered ACE inhibitors
  - 0.5 - 3 mg/kg PO q 12 h without ACE inhibitors
  - Reflex tachycardia & increase RAAS response

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Positive Inotropy

- Dobutamine
  - IV CRI 2.5 - 7 mcg/kg/min
  - Beta receptors downregulated after 72 hours -> not effective long term

- Pimobendan
  - maximize PO dosage: 0.5 mg/kg PO q 8 - 12 h

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Arrhythmia management - Afib

● Acute management of atrial fibrillation
  - **Calcium channel blockers:**
    - IV Diltiazem: 0.05 - 0.15 mg/kg IV over 5 - 10 minutes up to max dose of 0.3 mg/kg; then CRI (0.12 - 0.24 mg/kg/h)
    - PO Diltiazem: 0.5 - 2 mg/kg PO q 8 h
    - PO Dilitazem extended release (dilacor ER): 2 - 3 mg/kg PO q 12 h

● Chronic management
  - Diltiazem ER: 2 - 3 mg/kg PO q 12 h
  - Digoxin: 0.0045 mg/kg PO q 12 h

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Arrhythmia management - SVT

- Slow conduction through AV node (break re-entry) or slow ventricular response rate (atrial tachycardia)

- **Beta blockers**
  - Esmolol: 0.05 - 0.1 mg/kg IV boluses every 5 minutes up to max dose of 0.5 mg/kg; then CRI (10 - 200 µg/kg/min) (**short acting**)
  - Propanolol: 0.02 mg/kg IV slowly (**longer acting**)

- **Calcium channel blockers**
  - Diltiazem: 0.05 - 0.15 mg/kg IV over 5 - 10 minutes up to max dose of 0.3 mg/kg; then CRI (0.12 - 0.24 mg/kg/h)

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Arrhythmia management - SVT

- To convert focal atrial tachycardia and some re-entrant SVT
- **Lidocaine**
  - IV boluses of 1 - 2 mg/kg (up to 6 - 8 mg/kg total)
- **Procainamide**
  - IV boluses of 2 - 5 mg/kg up to 20 mg/kg total; each dose over 5 minutes
- **Sotalol**
  - 1 - 2 mg/kg PO q 12 h

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Other considerations

- Oral medications can be too stressful: temporarily DC ACE inhibitors, spironolactone, etc.
- Watch electrolytes with profound diuresis
- Cautious of hyponatremic CHF – poor prognosis and keeping up with salt loss
- Blood pressure monitoring
Pulmonary hypertension (PHT)
Pulmonary hypertension - diagnosis

- Clinical signs
- Signalment
Pulmonary hypertension (PHT) – causes in people

- Class I - idiopathic, familial, congenital heart disease, connective tissue disease, drugs, toxins, HIV, portal hypertension, hemoglobinopathies, myeloproliferative
- Class II - left heart disease
- Class III - lung disease and/or hypoxemia
- Class IV - chronic thrombotic/embolic disease
- Class V - miscellaneous - sarcoidosis X, tumor, lymphangiomatosis
Pulmonary hypertension (PHT) - dogs

- **Pre-capillary PHT (pulmonary arterial)**
  - Heartworm disease
  - Chronic pulmonary disease
  - Pulmonary thromboembolic disease

- **Increased pulmonary blood flow**
  - Overcirculation (L to R shunt… PDA, VSD)

- **Post-capillary PHT (pulmonary venous)**
  - Left-sided CHF (mitral valve disease, DCM, mitral stenosis)
• Sinus rhythm to tachycardia

• Right axis shift

• (Low voltage QRS complexes)
Thoracic radiographs
Echocardiogram
Echocardiogram
Echocardiogram
Treatment

- Anticoagulants
- Phosphodiesterase-5 inhibitors (PDE-5)
- Diuretics, digoxin, pimobendan, oxygen
- Calcium channel blockers (CCBs)
- Endothelin-receptor antagonists (ERAs)
- Prostacyclin analogues
Treatment

Smooth muscle cell

Dilate

ANP

Vasopressin (ADH)

Constrict

Endothelial cell

Prostacyclin (PGI₂)

Nitric oxide

Endothelin

Shear stress

Histamine

Ach

Bradykinin

Purinergis (e.g. ATP)

Shear stress

High shear stress

Cytokines

Thrombin

ACE
Anticoagulants

- Clopidogrel (Plavix)
  - ¼ of 75 mg tablet (18.75 mg) PO q 24 h in cats
  - 1 mg/kg PO q 24 h in dogs
- Aspirin
- Low molecular weight heparin

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Phosphodiesterase 5 inhibitors

- Sildenafil
  - 1 - 2 mg/kg PO q 8 - 12 h
  - Can titrate to 3 mg/kg PO q 8 h

- Tadalafil

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Diuretics, positive inotropes, oxygen

- Furosemide
- Hydrochlorothiazide/spironolactone
- Pimobendan
  - 0.2 - 0.4 mg/kg PO q 12 h
- Digoxin in people
- Oxygen

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Be cautious of overdiuresis
Calcium channel blockers (CCBs)

- Diltiazem
- Amlodipine
- For patients that are vasoreactive
  - Tested with invasive cardiac catheterization
  - Reduction of mean right atrial pressure (MRAP) of 10 mmHg or more
  - Achieve MRAP of < 40 mmHg with normal cardiac output
  - Tx with CCBs in patients with negative response is contraindicated
Synthetic prostacyclin & prostacyclin analogues

- IV epoprostenol
- SQ or IV treprostinil
- PO beraprost
- Inhaled or IV iloprost
Endothelin-receptor antagonists (ERAs)

- PO bosentan (active endothelin receptors A and B). Expensive
- PO Sitaxsentan (ETA only)
- PO Ambrisentan (ETA only)
Combination Therapy - humans

- Oral bosentan with IV epoprostenol - improved hemodynamics
- Oral sildenafil with IV epoprostenol - increased survival
- Oral tadalafil with oral bosentran - improved hemodynamics, exercise
- Drug interactions exist
Current recommendations

- Humans: early IV epoprostenol with PDE-5 inhibitor and/or ERA
- Veterinary: ???, treatment of underlying cause, sildenafil, oxygen
- Oral ERAs still cost prohibitive
Inadequate response

- Atrial septostomy
- Lung transplant
Questions

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