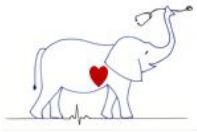
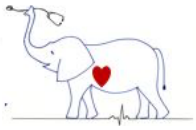




Acquired Myocardial Disease

Created by V'22 cardio group revised from Dr. John Rush

Last Updated: 9/25/20

Myocardial diseases: predominant cardiac lesion localized to the heart muscle (+/- endocardium & epicardium involvement)

Primary cardiomyopathies: myocardial disease of unknown cause

Myocarditis: inflammation of the heart muscle. Sequela to primary muscle disorder, immune-mediated diseases, or infectious agents (most common)

- Bacterial, viral, rickettsial, fungal, parasitic diseases can → myocarditis
- Usually, systemic signs of the infection >> clinical signs of myocardial involvement
- Myocarditis usually unrecognized until it is well-developed or post-mortem exam is performed
- Histopathology: inflammation and edema, lymphocytes and macrophages predominate
- +/- Fibrosis and fatty tissue replacement of myocytes
- Earliest recognizable findings
    - Sinus tachycardia
    - Cardiac arrhythmias
    - Non-specific ST-T changes on ECG
- Significant myocardial involvement
    - Cardiomegaly
    - Tachy- and bradyarrhythmias
    - Thromboembolism
    - CHF
    - Sudden death

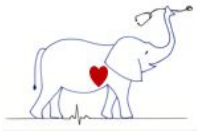
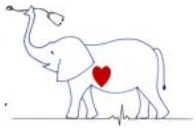
Bacterial myocarditis: usually a complication of bacterial endocarditis (direct extension from infected valve OR hematogenous spread)

- Immune-suppressed patients at increased risk

Viral myocarditis: uncommonly recognized in animals, varied effects on heart muscle

- Inflammatory lesion, myocytolysis and necrosis
- Predominantly mononuclear (lymphocytic) cell infiltration
- It is proposed that some cases develop due to immune-mediated mechanisms, not direct injury of myocytes by the virus

1. Parvovirus (dog)
    a. Peracute form: puppies 3-8 wk.
        i. Acute CHF, sudden death
        ii. Intranuclear basophilic inclusion bodies
    b. Delayed onset: puppies 3-5+ mo.

i. CHF, ventricular arrhythmias
ii. Dilated ventricles, scattered white foci over epi- and endocardium
iii. Myocardial necrosis, fibrosis

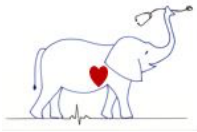
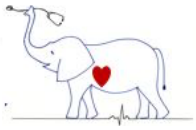
2. Picornavirus
    a. Foot and mouth disease (cattle, goat, sheep, pigs)
        i. Type C virus → myocarditis in adults
        ii. Lymphocytic myocarditis with hyaline necrosis and scattered neutrophils
    b. Encephalomyocarditis (pigs, primates, mice)
        i. Acute CHF – young pigs, especially
        ii. Dilated hearts, scattered white streaks in RV
        iii. Lymphocytic myocarditis with myocyte necrosis and calcification
        iv. Rats = reservoir host
3. Coronavirus (cats)
    a. DCM-like syndrome in young kittens
    b. Immune-mediated vasculitis in adult cats
        i. Non-cardiac, multisystemic signs > cardiac signs (usually)
        ii. Pericardial effusion
        iii. Myocardial involvement = rare

Fungal myocarditis: very rare in domestic animals
- Well-recognized, severe complication of disseminated systemic mycoses in humans

Spirochetal myocarditis: Lyme disease
- *Borrelia burgdorferi* reported to cause cardiac pathology in humans and dogs
- Variable degrees of AV block common

Protozoan infections: common cause of myocardial lesions, rarely → clinically significant myocarditis
- Clinical signs typically multisystemic or non-cardiac, localized organ involvement
- Myocardial effects (if present) likely due to pathogenic effects of organism AND host's immune response

1. Sarcosporidia, sarcocystis sp. (aquatic birds, most mammals – esp. herbivores)
    a. Cyst formation (sarcocysts) in cardiac and skeletal muscle throughout body
    b. Cyst will displace sarcolemma **without** inflammatory reaction → clinical signs absent
    c. In some calves – clinical signs and death reported if significant infection
2. Trypanosomiasis; Chagas' Disease (dog)
    a. Texas, Mexico, Central & South America
    b. Serious, often fatal disease caused by Trypanosoma cruzi
    c. Enzootic in wild animals in southern US (armadillos, rodents)
    d. Vector = Reduviidae, "kissing bugs"
    e. Causes severe myocarditis, primarily of the RA & RV → RCHF

   f. Necrotizing granulomatous myocarditis associated with both intra- and extracellular amastigotes of the organism
3. Toxoplasmosis (cat, dog, etc.)
   a. Intestinal coccidian of cats – Toxoplasma gondii
   b. Non-cardiac signs >>, multisystem involvement (i.e. GI, respiratory, CNS, ocular)
   c. Cardiac lesions = most common in dog/cat, rarely → clinical signs
      i. Gross = Scattered pale myocardial lesions
      ii. Microscopic = Necrotizing myocarditis associated with scattered pseudocysts
4. Encephalitozoonosis (rabbits/other lab rodents)
   a. Caused by Encephalitozoon cuniculi – microsporidium, obligate, intracellular protozoan parasite
   b. Urine-oral passage (rabbit colony), also fecal-oral, respiratory, and transplacental transmission possible
   c. Most infections = chronic, subclinical, diagnosed at post-mortem exam
   d. IF signs are present – typically CNS signs >> (i.e. paresis, convulsions, death)
      i. Myocarditis CAN develop and produce clinical signs/sudden death in young rabbits

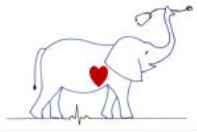
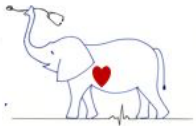
Myocardial lesions as a result of **<u>parasitic infection</u>**

- May be the result of hypersensitivity or non-specific inflammatory response to larvae presence, larval migration, or presence of encysted parasites in myocardium
- Sometimes vascular lesions due to larvae → myocardial lesions
- Myocardial lesions due to parasitic diseases = mild & asymptomatic, usually
  - EXCEPT: *Strongylus* spp. In equine and *Trichinella spiralis* in man → decreased myocardial performance, potential for CHF, sudden death

<u>Secondary</u> <u>myocardial diseases</u>: myocardial disease of known cause or origin

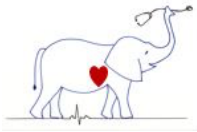
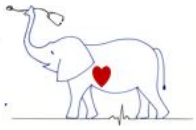
- Systemic disease which involves the myocardium
- Clinical myocardial disease present, but typically overpowered by non-cardiac manifestations of the disease
- Myocardial dysfunction can result from
  - Diffuse areas of myocyte death
    OR
  - Alteration in myocardial performance W/O recognizable microscopic changes
- Peripheral vascular effects (i.e. systemic hypertension, peripheral vasodilation, thromboembolism, shock) may contribute to changes in cardiac performance → myocardial dysfunction
- Prognosis is typically poor, unless underlying disease is recognized early and can be treated

1. Myocardial disease of known or suspected **heritability**
   a. Hereditary CM in Syrian hamsters
   b. Hereditary CM of turkeys (“round heart disease”)

c. Glycogenesis (glycogen storage diseases) or other inherited myopathies

2. Myocardial diseases secondary to **nutritional deficiencies**
    a. Selenium-Vitamin E deficiency (white muscle disease)
        i. Many species, including man
        ii. Myocardial and skeletal muscle necrosis
        iii. Etiology
            1. Low dietary selenium, vitamin E
            2. High dietary concentration of polyunsaturated fats
            3. Exposure to prooxidant compounds
            4. Intake of selenium antagonists (i.e. silver salt)
    b. Copper deficiency – adult cattle
        i. Cattle maintained in Cu deficient pastures
        ii. Microscopic findings = extensive myocardial fibrosis
    c. Thiamine (vitamin B1) deficiency – Beriberi heart disease
        i. Common in people living in undernourished regions
        ii. Hemodynamic changes
            1. Increased CO, SV
            2. Peripheral vasodilation – reduction in peripheral vascular resistance
    d. Taurine deficiency in cats and dogs (DCM)
3. Myocardial diseases of **toxic** etiology
    a. Cobalt cardiotoxicity
        i. Biochemical lesion – blocking oxidation of alpha-ketoglutarate & pyruvate
        ii. Myocardial energy metabolism is compromised (like in thiamine deficiency)
    b. Catecholamine cardiotoxicity
        i. May occur by increased circulating levels of endogenous catecholamines (as in pheochromocytomas) or by administration of exogenous catecholamines
        ii. Myocardial lesions – multifocal myocardial necrosis, most severe I LV subendocardium & papillary muscles
    c. Minoxidil (Loniten) cardiotoxicity
        i. Used in humans – vasodilator for refractory HT
        ii. In dogs, even very low doses → severe RA hemorrhage w/ inflammation, fibrosis and LV papillary muscle necrosis
    d. Doxorubicin (Adriamycin) and Daunorubicin (Cerubidine) cardiotoxicity
        i. Antineoplastic drug used in chemotherapy
        ii. Cumulative toxicity → DCM-like syndrome with severe CHF
            1. Develops when maximum total cumulative dose > 240 mg/m2 (sometimes at lower doses if breed is predisposed to CM)
        iii. Microscopic myocardial lesions: sarcoplasmic vacuolization, myocytolysis, hyaline necrosis
    e. Furazolidone cardiotoxicity in poultry

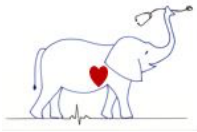
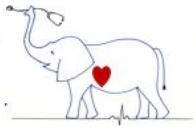



i. Antibiotic used as food additive
ii. Accidental exposure to excessive amounts (typical cause) → CHF
iii. Turkeys, ducklings, chickens

f. Renal failure
i. Associated myocardial necrosis as likely sequela to SHT
ii. Focal lesions severe in LV subendocardium, uremic vasculitis can contribute
iii. Target end organ damage
1. LV hypertrophy
2. Glomerulosclerosis and progressive renal failure
3. Retinal hemorrhage or detachment → blindness
4. Hypertensive encephalopathy/CNS stroke/hemorrhage → neuro deficits

4. Myocardial disease associated with **physical injuries**
a. CNS lesions
i. Myocardial necrosis and/or hemorrhage
ii. Lesions similar to result of excessive catecholamine administration
b. Electric shock; defibrillation
i. Focal myocardial necrosis – occurs in areas of high current density
ii. Factors increasing severity of necrosis
1. High strength shocks, use of small electrodes
2. Multiple shock delivery
3. Frequent shocks with short rest intervals between
c. Hemorrhagic shock
i. Most severe lesions in LV subendocardium and papillary muscles
ii. Subendocardial hemorrhage and microscopic regions of focal necrosis
iii. Trauma, GDV, splenic mass, pancreatitis, etc.
iv. Associated with development of ventricular arrhythmias, high cardiac troponin I

5. Myocardial disease associated with **endocrine disorders**
a. Diabetes mellitus
i. Myocardial lesions in man and genetically diabetic mice only
b. Hyperthyroidism
i. Cardiac changes secondary to hyperthyroid state in humans and domestic cats
ii. Effects due to increased circulating levels of thyroid hormones on the heart and peripheral vascular beds, as well as increased sensitivity of heart to endogenous catecholamines
1. Increased CO, HR, LV EF
2. Decreased PVR, circulation time
3. Widened pulse pressure
iii. Thyroid hormone stimulates protein synthesis → myocardial hypertrophy (microscopic change + increased # of mitochondria)

iv. Non-cardiac signs (weight loss, intermittent vomiting, diarrhea, nervousness) >> cardiac signs (tachycardia, arrhythmias, CHF) of hyperthyroidism
    1. BUT cardiac signs are usually prominent on clinical exam and most life-threatening

c. Amyloidosis
    i. Multisystem disease, deposition of amyloid (fibrillar glycoprotein) in various tissues throughout the body
    ii. Deposition in kidneys, liver, other non-cardiac tissues occurs with some chronic infections, inflammatory and neoplastic diseases → dysfunction of affected organs → clinical signs
    iii. Cardiac involvement = rare

Deposition in endocardium, myocardium, pericardium, valve leaflets, conduction system, intramural coronaries can occur → variety of cardiac manifestations & severe cardiac dysfunction