Emergency Management of Acute Heart Failure

Tony Johnson, DVM, DACVECC
Veterinary Information Network & Purdue University School of Veterinary Medicine
Davis, CA and West Lafayette, IN, USA

When managing cardiac failure in the emergency setting, we are often dealing with the management of syndromes and symptoms without necessarily knowing the cause. While a definitive diagnosis provides the best guide for treatment, obtaining that diagnosis (typically through echocardiography) may place an unstable patient at serious risk.

We will therefore discuss the management of cardiac syndromes and then briefly review their causes. We will discuss each of the syndromes separately, but note that they often occur concurrently.

General concepts:

Common syndromes and causes associated with cardiac failure:
1. Left sided congestive failure (L-CHF) – typically due to decompensated valvular disease
2. Right sided congestive failure (R-CHF) – typically due to pericardial effusion
3. Low output or “forward” failure – typically due to hypertrophic cardiomyopathy in cats or dilated cardiomyopathy in dogs

Definitions:
- **Afterload**: systemic arterial blood pressure (pressure against which left heart must pump to get blood flow through the systemic vasculature)
- **Preload**: ventricular filling pressure (pressure against which blood must enter into the ventricles during diastole)
- **Congestive heart failure**: “Congestive” implies venous congestion followed by leakage fluid from the blood vessels into the surrounding tissues, as governed by Starling’s forces.
- **CVD**: Chronic valvular disease

I. Left Sided Congestive Heart Failure

Key clinical sign: **PULMONARY EDEMA and DYSPNEA**

(A) Pathophysiology

\[ \uparrow \text{Left Atrial Pressure due to CVD and valve leakage (backwards flow of blood in systole)} \]

\[ \uparrow \text{Pulmonary Venous Pressure (Hydrostatic pressure)} \]

\[ \rightarrow \text{Pulmonary Edema} \]

(B) Clinical Signs

- **Coughing** Usually soft cough compared to tracheobronchial cough. May be productive. If particularly severe, may produce clear to serosanguinous frothy fluid. Coughing is RARELY associated with heart disease in cats.
- **Exercise intolerance**
- **Cyanosis**
- **Dyspnea** Can be seemingly sudden in onset, particularly in cats, or may be more insidious. Patient may show “air hunger” (standing with head and neck
extended and forelimbs abducted). Common complaint is inability to sit or lay down/restlessness. Once asleep, may sleep for protracted periods of time, particularly once pulmonary edema under control.

- Pulmonary edema
  Radiographically this can appear as a peri-hilar interstitial (early or mild) to alveolar (late or severe) pattern on radiographs, but it can be highly variable in cats. Appearance in cats can be patchy, and not perihilar.

(C) Therapeutic Goals

1. Decrease **left atrial pressure** (LAP)
   a. Decrease preload (minimizes left ventricular and hence left atrial filling pressures)
      i. Diuretics such as furosemide
      ii. Venodilators
   b. Decrease afterload (arterial blood pressure)
      i. Arterial dilators like enalapril and pimobendan
   c. Decrease pre- and after-load
      i. Balanced vasodilators

   CAUTION: An excessive fall in preload through overuse of diuretics can reduce filling pressure below a critical level thus causing a decrease in ventricular filling and stroke volume. An excessive decrease in afterload can cause weakness and syncope. Excess of both can therefore have detrimental effects on cardiovascular function!

2. **Improve cardiac function** if indicated (i.e. DCM, end-stage CVD)
   a. Improve systolic function
      i. Positive inotropes (dobutamine, digoxin, pimobendan)
      ii. Phosphodiesterase inhibitors (pimobendan)
   b. Improve diastolic function
      i. Slow heart rate (digoxin, beta-blockers, calcium channel blockers)
      ii. Relax heart muscle (calcium channel blockers)
      iii. *NOTE* do not use negative inotropes until AFTER CHF is resolved!!

3. Provide **supportive care** until pulmonary edema is under control
   a. Oxygen: Nasal, mask/flow-by, transtracheal, cage
   b. Comfort/pain control:Narcotics, Valium, (+/- low-dose acepromazine?)
   c. Cage rest
   d. Nutritional support?

The typical dog presenting for cardiac failure often requires a combination of treatments for L-CHF and low output failure. Typical therapy includes:
- Furosemide @ 2-4mg/kg IV q2-4 hours as needed.
- Furosemide CRI (continuous rate infusion) can also be helpful, and may be more beneficial at resolving edema: 0.1 to 1 mg/kg/hr
- Oxygen support and cage rest
- Sedation (consider morphine or butorphanol)
- **IF** + inotrope needed/included, Dobutamine @ 5-10 ug/kg/minute IV *initially*
- +/- Sodium nitroprusside @ 3-5 ug/kg/minute IV *initially*
- Nitroglycerine paste is not effective for vasodilation
- Refractory cases may benefit from sedation, intubation and postural drainage of edema fluid (mechanical ventilation may also be needed)
Cats are more sensitive to stress and lasix. A severely dyspneic cat with pulmonary edema might require furosemide IM, sedation and to be placed in an oxygen cage (and left alone) until it is more stable for IV catheters, diagnostics, etc. Cats are also more prone to accumulation of pleural fluid than dogs and may benefit from immediate thoracocentesis.

II. Right Sided Congestive Heart Failure
Key clinical signs: ASCITES and/or PLEURAL EFFUSION (the former is more common in dogs, latter is more common in cats)
(A) Clinical Signs
- Ascites
  Distended abdomen, discomfort/restlessness/difficulty sitting/laying. Can cause compromise when severe by pushing on diaphragm and decreasing effective lung capacity
- Pleural effusion
  Dyspnea, tachypnea, rarely coughing

(B) Therapeutic Goals
1. Mechanically remove fluid: peritoneal, pericardial, or thoracocentesis
2. Decrease right atrial pressure
   a. Decrease preload
      i. Diuretics> in RHF diuretics are the safest means of reducing preload (see important exception below for pericardial effusion).
      ii. Venodilators> In RHF, venodilators will often decrease right ventricular filling pressures below critical level. In a failing right ventricle this critical level occurs at a higher venous pressure. Therefore, venodilators may exacerbate RHF. Dehydration will also decrease right atrial pressures and have a similar detrimental effect on RV filling.
   b. Increase cardiac output
      i. Positive inotropes> increasing CO from the right side will also decrease right atrial pressures. Effective selective pulmonary arterial dilators are not available and thus positive inotropes are the only available means to increase CO from the right side.
      ii. Fluid support/vascular expansion> particularly with pericardial effusion. IV fluids can make large difference in cardiac output, particularly if pericardiocentesis cannot be performed immediately. Once tapped diuretics are rarely required.

The typical case presenting in acute R-CHF often requires some form of centesis, followed by moderate doses of lasix (1-2 mg/kg 8-12 hours) and a positive inotrope such as digoxin.

**REMEMBER> always consider pericardial effusion in any animal, especially middle to old aged large breed dogs with signs of acute R-CHF!! Pericardial effusion cases are the one R-CHF in which diuretics and vasodilators are contraindicated, as these drugs will further decrease cardiac output. IV fluids and volume expansion are indicated until pericardiocentesis can be performed**
Biventricular failure often occurs in the later stages of disease, especially with DCM and end-stage chronic valvular disease. Often, patients have a history of L-CHF, but not always. The prognosis is guarded at this stage. Manage the case as above, but note carefully the comments about vasodilators with R-CHF.
III. Low Output Cardiac Failure
Key clinical sign: WEAKNESS, POOR PERFUSION (cold extremities, prolonged CRT)

(A) Pathophysiology
Pump Failure > systolic dysfunction > myocardial disease
Decreased cardiac filling > diastolic dysfunction > small chamber size, tachycardia

(B) Clinical Signs
- Exercise intolerance due to poor muscle perfusion from poor cardiac output
- Blanched mm, slow CRT due to poor cardiac output
- Cold extremities due to poor cardiac output
- Possible signs of CHF depend upon degree of venous back up > can be right and/or left sided

(C) Therapeutic Goals
1. Increase Cardiac Output
   a. Improve diastolic function
      i. HCM
         1. Negative inotropes and chronotropes to relax the heart muscle for improved filling space and slow the heart rate for increased filling times
            a. Calcium channel blockers (diltiazem) & beta-blockers (propanolol, atenolol) are both negative inotropes and chronotropes
      ii. Pericardial effusion
         1. Pericardiocentesis
         2. *Avoid pre-load reducers like furosemide until AFTER centesis performed
         3. May need to increase pre-load (i.e. IV fluid therapy)
   b. Improve systolic function
      i. Positive Inotropes (DCM and CVD)
      ii. Afterload reducers (decreasing peripheral vascular resistance (PVR) allows increased stroke volume. Remember, SV = systolic pressure/PVR, and CO = HR X SV

2. Treat signs of CHF (see previous sections)

IV. Common Cardiac Diseases Associated with the Above Described Cardiac Syndromes:
1. Chronic Valvular Disease (CVD)
   This is the most common cause of CHF, and usually seen in small and toy-breed dogs. The mitral valve is the most common valve adversely affected. In the early stages of the disease, these patients present with mild L-CHF. This will often be progressive and animals present to the ER at this stage with decompensated L-CHF. If chordae tendinae rupture occurs, low output failure may also be seen as large volumes of blood regurgitate into the left atrium. This causes an acute rise in left atrial pressures often causing peracute, severe L-CHF.

2. Dilated Cardiomyopathy (DCM)
A primary pump failure leading to both low output failure and L-CHF. As the disease progresses, bi-ventricular failure may be seen, thus R-CHF signs may also be seen. Biventricular failure is a poor prognostic indicator.
Canine: Dogs usually present in L-CHF and low output failure. Often atrial fibrillation is seen. Dogs with advanced disease will often show signs of bi-ventricular failure.

Feline: Cats usually present in low output and bi-ventricular failure. They often present with life-threatening pleural effusion.

3. Hypertrophic Cardiomyopathy (HCM)
This occurs primarily in cats/rarely dogs. Cats present with signs of L-CHF due to diastolic compromise. They may show signs of bi-ventricular failure. Dogs with secondary hypertrophy (i.e. due to sub-aortic stenosis) usually present with ventricular arrhythmias.

4. Pericardial Effusion
Dogs present with signs of R-CHF and low output failure due to diastolic compromise as a result of extra-cardiac compression and right atrial tamponade.

Other Less Common Cardiac Diseases that cause heart failure syndromes:
- Congenital anomalies (VSD, ASD, PDA, SAS, tricuspid & mitral dysplasia)
- Parvovirus cardiomyopathy
- Feline endomyocarditis and other feline cardiomyopathies (restrictive, intermediate)
- Heart-based tumors (Chemodectoma) and infiltrative cardiac tumors (lymphoma)
- Bacterial endocarditis (rarely, if ever, causes failure)
- Primary arrhythmias
- Boxer cardiomyopathy
- Cocker spaniel DCM (taurine/carnitine responsive?)