Merilee

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SWAN - GANZ CATHETER PLACEMENT

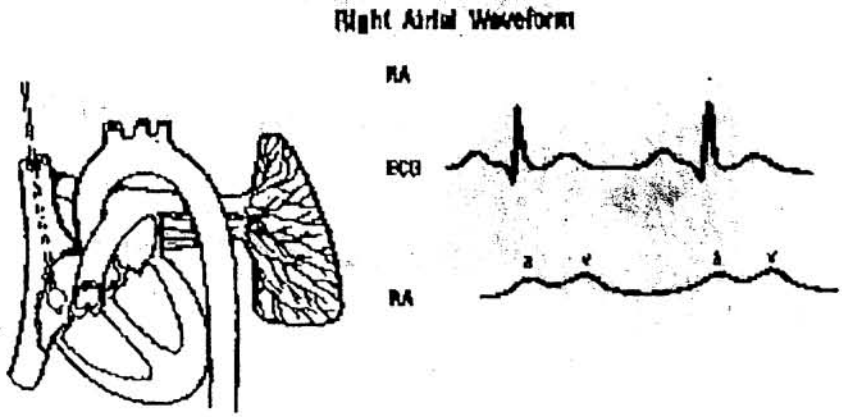
Materials

Swan Catheter
Percutaneous catheter introducer (PC): Swan must be a half size smaller than the PC.
Flush, heparinized saline
10 cc syringe, sterile for flush
Transducer, pressure bag, lines, male to male if A-line
Gloves, sterile
Stop cocks and injection caps (4 of each)
Eye drape, sterile

Prepare a sterile work place to lay catheter, stopcocks, injection caps and heparinized flush. An eye drape is useful as a sterile field on the dog. Fill catheter ports with flush. Estimate the distance from the PC to the right atrium (4 th intercostal space).

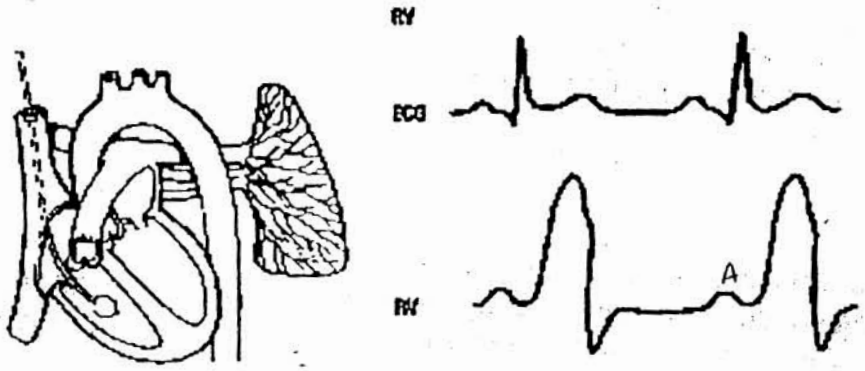
Placement of the Swan Ganz Catheter

Moisten the Swan balloon and then test the balloon by inflating with the proper amount of air, usually 1.5 cc. Moisten the whole catheter before placing it through the PC. PLACE THE CONTAMINATION SHEATH OVER THE SWAN AT THIS TIME. Place Swan into the PC about 10 cm pointing dorsally to help avoid traveling down tributaries of the jugular. Partially inflating the balloon once in the jugular may help advance it into the right atrium (RA). Hook up the transducer to the catheter. Advance catheter the estimated distance. If not getting a right atrial (RA) pressure curve, then advance another 5 - 10 cm. If still no success, then withdraw back to the 10 - 15 cm mark and advance again. It is possible that the catheter will go down a venous tributary.

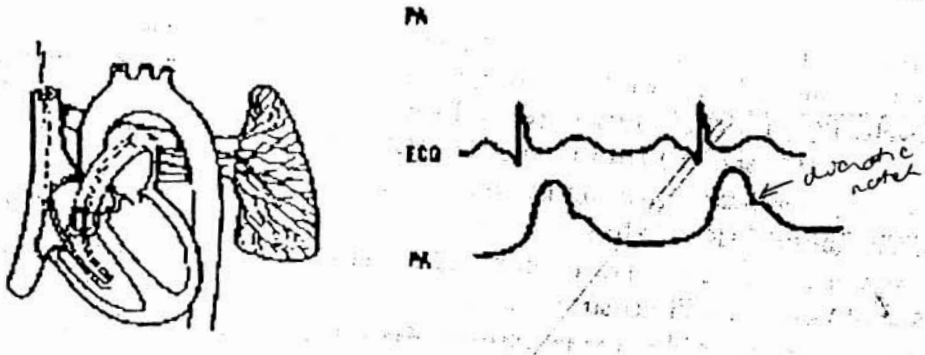


Once in RA, the catheter may be advanced with the balloon inflated or deflated into the right ventricle (RV). Once in the RV, inflate the balloon because this will aid in floating it into the pulmonary artery (PA). Never withdraw the catheter with balloon inflated, especially across a valve area. If there is difficulty getting into the RV from the RA (sometimes the catheter will travel up the azygous or out caudal vena cava), then withdraw (BE SURE BALLOON IS DEFLATED) and give the catheter a 1/4 turn and advance again. Sometimes changing the dogs neck position or sitting dog in sternal position may help it enter the RV.

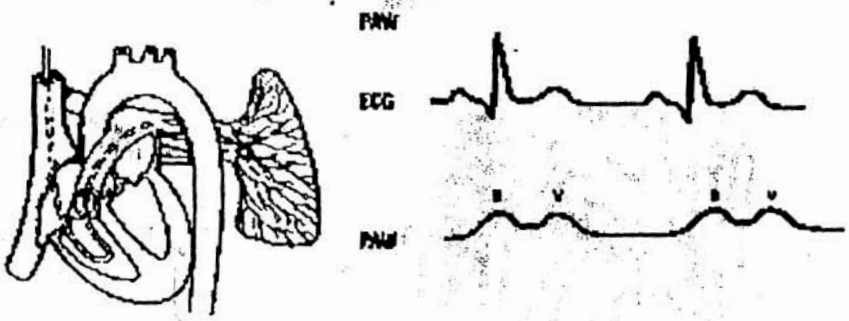
Right Ventricular Waveform



Pulmonary Artery Waveform



Pulmonary Artery Wedge Waveform



COMPLICATIONS OF PULMONARY ARTERY MONITORING

1. Complications of the use of PA catheters may be attributed to catheter insertion, advancement, or maintenance. Frequency of these complications vary among reports. Most complications can be avoided if the clinician is aware of the risks, understands why these complications occur and use techniques to reduce their incidence. A recent study concluded that experience, supervision of trainees, and attention to detail were of primary importance in minimizing the incidence of complications.

   a. Insertion
      arterial puncture
      pneumothorax
      air embolism

   b. Placement
      dysrhythmias, including ventricular tachycardia and fibrillation and complete heart block are probably the most common and most serious complication associated with PA catheter placement
      knotting and coiling

   c. Maintenance
      infections (skin site, catheter)
      pulmonary infarction
      PA rupture
      balloon rupture
      thrombosis
      thrombocytopenia
      cardiac arrest

   d. Other

      mesmerism
      misinterpretation
      expense

GUIDELINES FOR USE OF PULMONARY ARTERY CATHETERS (PACs)

1. Spontaneous distal migration of the catheter is a frequent problem with PACs and may lead to
   a. wedging of the catheter even though the balloon is deflated (which may induce pulmonary infarction)
   b. perforation

2. Therefore, the catheter tip should be kept centrally located in a main branch of the pulmonary artery between reading wedge pressures

   a. avoid large loops in the RV when initially placing the catheter
   b. float in to read the wedge, and pull the catheter out a few cms after reading the wedge (Remember to deflate the balloon first!)
   c. if the wedge is achieved with less than a full balloon volume (1.5 ml with the 7.5 F catheters), then withdraw the catheter slightly and try again
   d. check the pressure tracing as the balloon is being inflated; if the pressure tracing starts to go up (instead of down), withdraw the catheter slightly and try again

3. Care should always be taken when inflating the balloon to prevent pulmonary artery rupture

   a. check the pressure tracing before inflating the balloon; if the trace is dampened or distorted, this may mean that the catheter is wedged with the balloon deflated. Check catheter placement before inflating!
   b. inflate the balloon slowly while continuously monitoring the pressure waveform and stop immediately when it changes from a pulmonary artery trace to a pulmonary wedge trace.
   c. never overinflate the balloon beyond the volume printed on the catheter shaft; use the volume-limited syringe provided with the catheter and do **not** remove the syringe from the balloon tip port

4. **Obtain a pulmonary artery occlusion "wedge" pressure ONLY WHEN NECESSARY.**

   a. wedge pressure time should always be kept to a **minimum** (3 or 4 respiratory cycles or 10 to 14 seconds), especially in patients with pulmonary hypertension
   b. if difficulty is encountered in obtaining a wedge, then give it up
   c. if the PA diastolic pressure equates with the wedge, then PAD should be used instead of repeatedly wedging the balloon; this may be done as long as heart rate, blood pressure, cardiac output and clinical status remain stable- it may not be possible with a septic or otherwise "shocky" patient

GUIDELINES FOR THERMODILUTION CARDIAC OUTPUT

1. Inaccurate cardiac output meassurements due to irregular cardiac output curves may be caused by

   a. changes in heart rate or blood pressure
   b. thermistor-vessel wall contact (position of the catheter is important!)
   c. poor-injectate-blood mixing
   d. abnormal respiratory patterns

2. Injectate volume and temperature will affect cardiac output measurement.

   a. although 10 ml volumes are typically used in man, 2.5 - 5 ml volumes can be used where volume overload is a concern
   b. syringes should be carefully filled to avoid error due to variable injectate volumes and to avoid administration of air bubbles
   c. injectate temperatures can range from 0 to 24° C
   d. colder injectate temperatures provide a greater signal-to-noise ratio for better accuracy and precision but may lead to: output error due to injectate warming by the hands, difficulty in maintaining the temperature of the injectate, and hypothermia-induced arrhythmias

3. Speed of injection is of minimal consequence if delivered in less than 4 seconds (10 ml)

4. Timing of the injection to the respiratory cycle can improved reproducibility of the cardiac output measurements and end-expiration is frequently used.

   a. with PPV, variation in cardiac output in correlated with cyclic variations in right ventricular cardiac output
   b. because it is frequently difficult to synchronize injection with end expiration, especially with patients on a ventilator, an average of three evenly spaced measurements is frequently used to provide a relatively accurate estimate of cardiac output

5. Certain conditions may intervere with the accuracy of the cardiac output measurement, including tricuspid regurgitation, cardiac arrhythmias, and intracardiac shunts

6. THE CLINICAL APPLICATION OF CARDIAC OUTPUT HAS LIMITATIONS. The appropriate clinical use of cardiac output necessitates combination with other indices to assess adequacy of tissue perfusion (eg SvO_2, urine output)

Table 3. Normal Ranges For Commonly Measured Cardiovascular Parameters in Dogs and Cats.

	Dog	Cat
Heart rate (min-1)	100-140	110-140
Mean arterial pressure (mm Hg)	90-120	100-150
Cardiac output ($ml \cdot kg^{-1} \cdot min^{-1}$)	100-200	120
(L/M2/min)	167 ± 39	
	4.72 ± 1.09	
Systemic resistance mmHg/ml/kg/min	0.64 ± 0.16	
dynes.sec.cm-5	2162 ± 458	
Mean pulmonary arterial pressure (mm Hg)	14 ± 3	
Central Venous pressure (cm H_20)	3 ± 4	
Pulmonary artery occlusion pressure (mm Hg)	5 ± 2	
Oxygen delivery (ml/kg/min)	29 ± 8	
(ml/M2/min)	815 ± 234	
Oxygen consumption ($ml \cdot kg^{-1} \cdot min^{-1}$)	4-11	3-8
(ml/M2/min)	7 ± 2	
	198 ± 53	
Oxygen extraction (%)	25 ± 3	
Blood volume ($ml \cdot kg^{-1}$)	75-90	47-66
Total plasma proteins ($G\ dl^{-1}$)	6.0-7.8	6.0-7.5
Packed cell volume (%)	40-55	25-45
Hemoglobin ($G\ dl^{-1}$)	4-17.5	8-15

Farver et al. Cardiopulmonary effects of acepromazine and of the subsequent administration of ketamine in the dog. AJVR, 47(3): 631-635,1986.

(Parameters obtained from conditioned, mixed breed dogs using a pulmonary artery catheter and thermodilution.)

Burkett.

(Parameters obtained from 17 male/female mixedbreed dogs, age 13 - 18 months, weights 18 - 25 kg. Instrumented with vascular access ports for direct measurement of mean arterial blood pressure and right atrial pressure(CVP) and aortic root ultrasonic blood flow transducers for direct measurement of cardiac output. All measurements were performed in conscious, trained and sling restrained dogs. All measurements were performed at least 3 weeks following the surgery to implant the described instrumentation.)