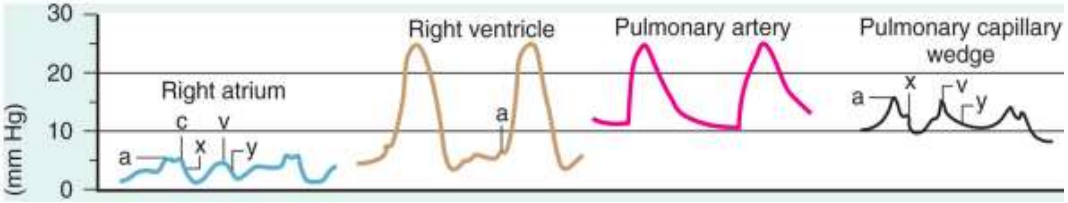
Right Heart Catheterization

Swan Ganz Catheter

- A 120-cm long, multi-lumen, balloon-tipped catheter. Usually 7.5 fr.
- Connected to a pressure transducer and temperature sensor.
- Inserted through a central venous access (R IJ, L subclavian, femoral vein).
- Waveforms rise and fall due to Δ blood volume or Δ myocardial fiber tension (ie. chamber size)
- Appropriate flushing, leveling and zeroing at Phlebostasis axis (Mid axillary line x 4th ICS)
- Help in ddx types of shock, type of pul edema, dx L→R shunt, pul HTN, hemodynamic tailored therapy in HF.
- No benefit in RCT of ADHF (ESCAPE JAMA 2005) and should not be routinely use (Ann Int Med 1985;103:445, Am J Med 2005 118, 449)

Tips

- Time the wave with the ECG. Pressure waveforms are slightly delay after ECG.
- Use all numbers together and observe changes or trends.
- The waveform morphology is important. (Am J Med 1987.83;111).
- Know which numbers are directly measured, which numbers are from calculation!
- On round, present RA, PA, PCWP, CI, and SVR then add other parameters (TPG, PVR) if relevant.



RA (6 mmHg)	RV (24/6 mmHg)	PA (24/12 mmHg)	PCWP (12 mmHg)
• Venous waveform (2 up, 2 down per cardiac cycle) A: Atrial systole - Increased in RV infarct, PS, PE, Pul HTN - Giant Cannon a waves in A-V dissociation, 3'AV block, VT X: atrial relaxation - Increase in restrictive and constrictive disease - Decrease in severe tricuspid regurgitation C: bulging of the AV valve V: filling of atrium (atrial diastole) - large C-V waves in TR Y: emptying of the RA into RV - Increase in early restrictive, severe TR - Blunted in TS, RV infarct and frank tamponade.	• Rapid upstroke followed by a rapid downstroke. Rasing during diastole Complication • **Misinterpreted data**: wrong data is worse than no data • **Insertion**: complication of vasc access, arterial puncture, pneumo/hemothorax, air embolism, ventricular arrhythmias, RBBB (3' AV block in preexisting LBBB, knotting • **Maintenance**: PA rupture, pul infarct, infection, thrombus formation.	• Rapid upstroke with dicrotic notch on down slope, down rending during diastole Pul Hypertension: mPA > 25 mmHg	• Venous waveform - confirm by O2sat > 95% - Surrogate of LV filling pressure PCWP: • PCWP is assume to be equal to LA and LVEDP • If PCWP > PAd pressure Inaccurate measure • PCWP > LVEDP in MS PV disease • PCWP < LVEDP AR Diastolic dysfunction

Common pitfalls

- Failure to level
- Dampening due to air in the system
- Not measuring at end expiration (high point in spontaneous breathing. Sunrise and Valley)
- Partial wedge (in PH)
- Use computer reading number
- ? Subtract 1/2 PEEP from the values.
- 10 cm H2O = 7.35 mmHg

Flow: Cardiac output (CO, L/min) are commonly indirectly "measured" by

CO by thermodilution:	**CO by Fick:** "Gold standard"
• Indicator dilution method • Injecting known amount and temp of fluid to a proximal port and measure Δ temp at distal port. CO = Reverse area under the curve • Limit in TR, shunt, low CO, rhythm disturbances, incorrect constant number.(Crit Care Med 1993; 21:586)	• Constant of mass • Measure O2consumption, SaO2sat, MvO2Sat, and Hb. $CO = \text{O2 consumption} / \text{A-V O2 difference} = \frac{(VO2)}{10 \times 1.34Hb(SaO2 - MvO2Sat)}$ • Limit in shunt, inaccurate assumption of VO2 (circ 2014;129:203)

Hemodynamics: Know the unit, understand the relations (formula)

Parameter and relations	Normal value and unit
V = I R	Δ BP = CO x SVR
CO	= 5 L/min
BSA	= 2 m2
CI = CO / BSA	= 2.5 L/min/m2
HR	= 70 bpm
SV = CO / HR	= 70 ml/beat
SVI = SV / BSA	= 35 ml/beat/m2
SVR = (MAP – CVP) x 80 / CO	= 1300 dynes.sec/cm5
PVR = (mPA – PCWP) / CO	= 1 wood unit
TPG = mPA - PCWP	= 5 mmHg
Ao	= 120/80 mmHg
A O2sat	= 95-100 %
Mixed V O2sat	= 75 %
A – V O2 content difference	= 20 – 15 = 5 ml/dL
EF = LVEDV-LVESV / LVEDV	
LVSWI = SVI x (MAP-PCWP) x 0.0136	= 50 – 62 g/m2/beat
RVSWI = SVI x (mPA-CVP) x 0.0136	= 5-10 g/m2/beat

Shunt Study "Sat run":

- O2 saturations were measured from multiple site of the heart.
- A step-up in O2Sat of >7% (RA level), 5% (RV or PA level) indicate left to right shunt.
- Inpatietn with shunt
  - CO by TD is inaccurate
  - CO by Fick need to use calculated mixed venous sat

Shunt calculation

- $MvO2Sat = \frac{(3SVC + 1IVC)}{4}$
- $Qs = \frac{(O2\ consumption)}{(13.4 \times Hgb \times (AO2 - MvO2Sat)}$
- $Qp = \frac{(O2\ consumption)}{(13.4 \times Hgb \times (PVO2 - PAO2Sat)}$
- $Simplified\ Qp/Qs = \frac{(AO2 - MvO2sat)}{(PVO2 - PAO2sat)}$