Pulmonary Artery Catheter Insertion

Introduction

Pulmonary artery catheters (PAC) are the gold standard in cardiac output (CO) monitoring, rarely seen in general ICU and anaesthesia practice due to complication rates and newer, less invasive CO monitoring. They are still used with relative frequency in cardiac surgery and cardiac ICU to guide treatment.
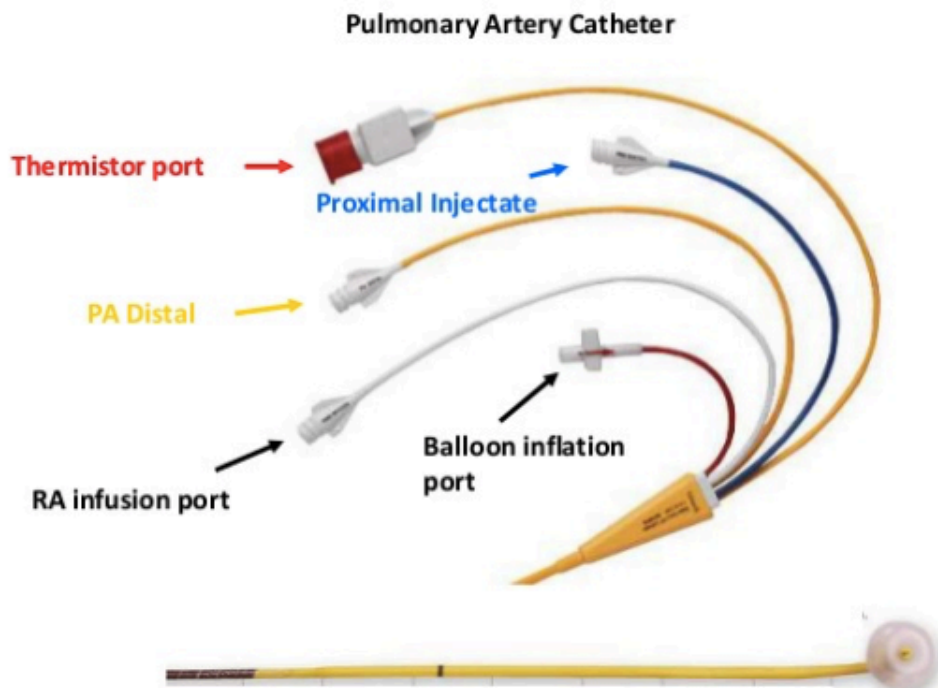
Uses

- Assessment of volume status where central venous pressure is unreliable
- Sampling of mixed venous blood to calculate shunt fraction
- Measurement of cardiac output using thermodilution
- Direct assessment of preload
- Calculate derived values from CO to estimate PVR, afterload, oxygen delivery and uptake

Indications
Left ventricular failure with pulmonary oedema
Interstitial pulmonary oedema
Chronic pulmonary disease
Valvular heart disease
Multi-organ failure
Evaluation/diagnosis pulmonary hypertension
Assess volume status in shock
Assessment of right-sided valvular disease, congenital heart disease, cardiac shunts, when surgical repair is planned

Contraindications	
Absolute	**Relative**
Coagulation defects	LBBB
Right heart thrombus/mass	Dysrhythmias
Tricuspid or pulmonary endocarditis	
Infection over insertion site	
Right sided ventricular assist device	
Tricuspid or pulmonary valve replacement	

Equipment:

- Sterile line insertion pack with ultrasound probe and cover
- PAC
- PA sheath
- Ultrasound
- PAC transducer
- Ice
- PAC thermodilution measurement kit
- Compatible monitoring
- Trained assistant

Pulmonary Artery Catheter

Thermistor port

Proximal Injectate

PA Distal

RA infusion port

Balloon inflation port

The standard catheter is 7.5 FR and 110 cm long. Maximal balloon volume 1.5cc

Ref: https://i.pinimg.com/originals/55/df/95/55df95719c7c4abad4e5e965a70e41a7.png

Method

Prior to starting check all equipment, flush line and insure balloon intact

Figure 1: Insert PA sheath using Seldinger technique and ultrasound guidance

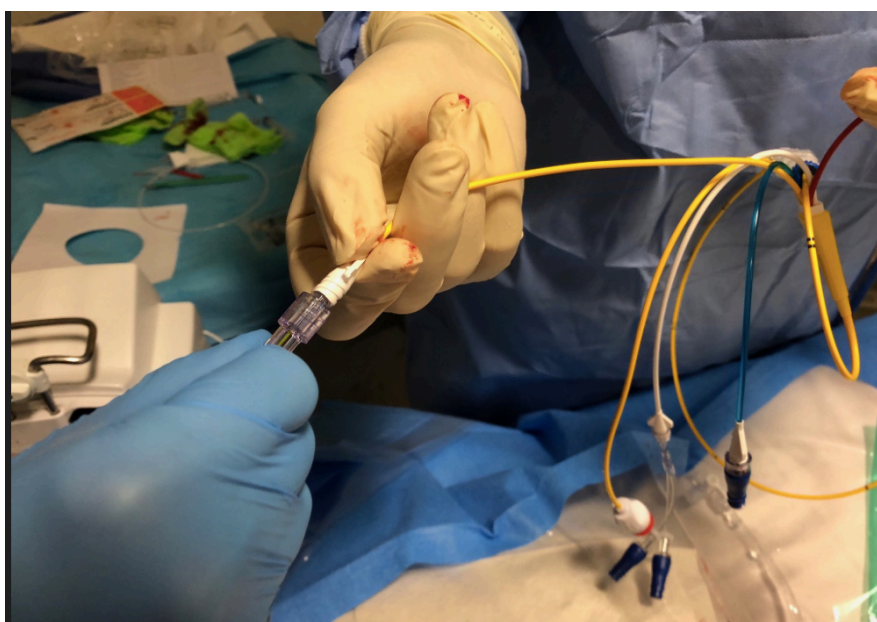*Figure 2: Maintaining sterility attach to PAC transducer and zero*

Figure 3: Advance PAC through non return valve into PA Sheath

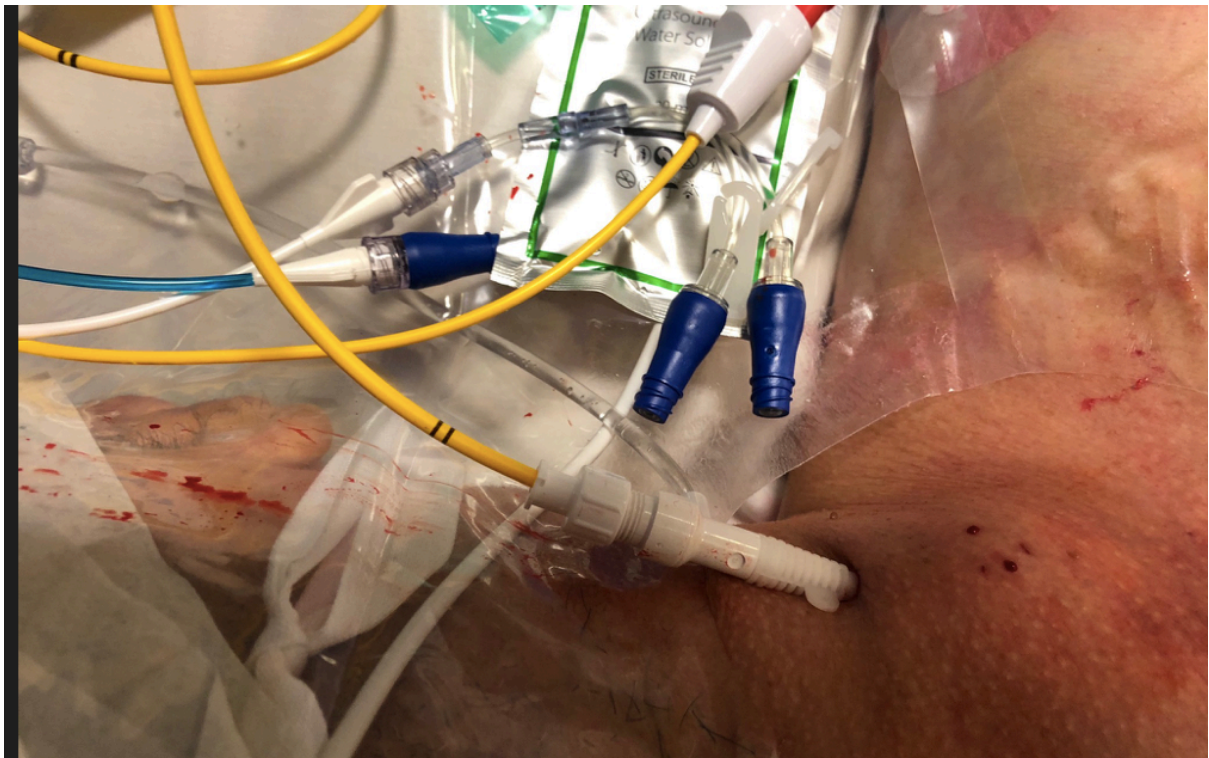*Figure 4: Insert PAC to at least 10cm to clear the end of the PA introducer*

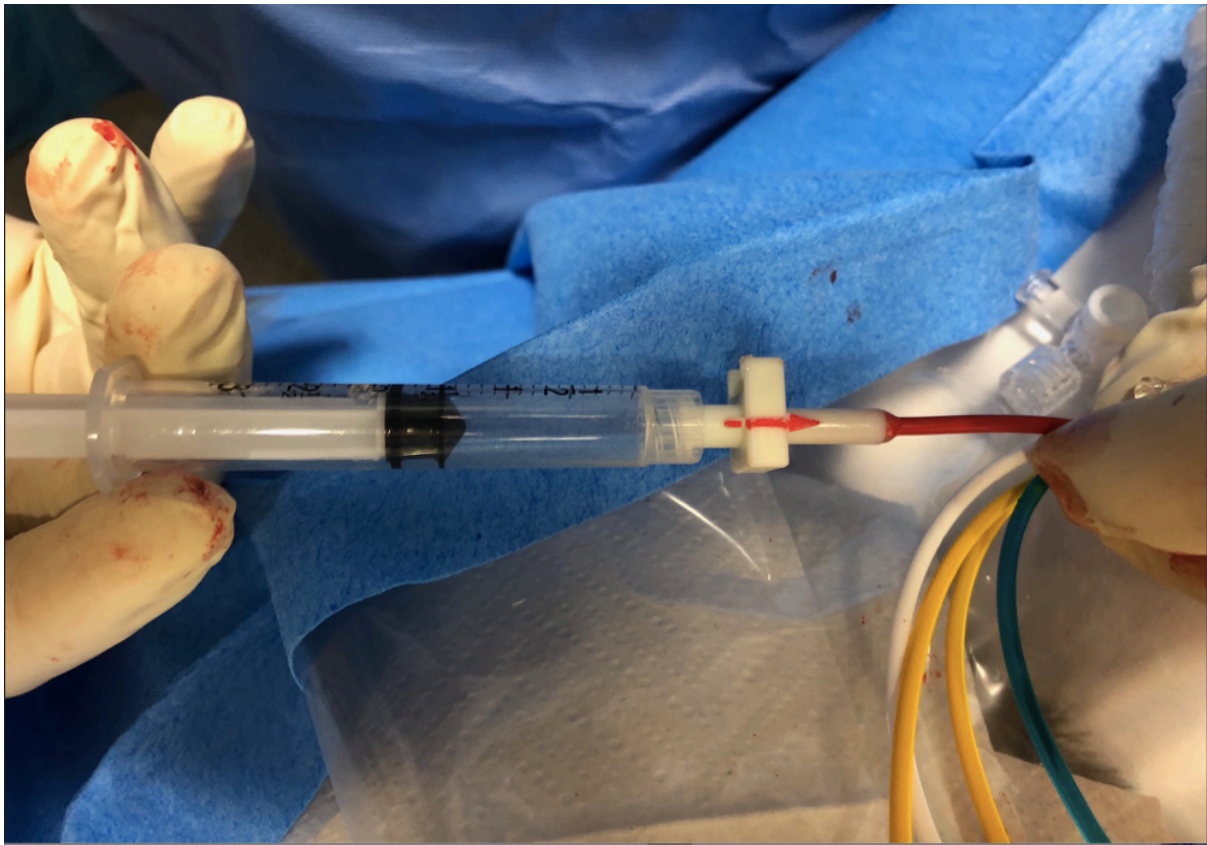*Figure 5:   Inflate balloon with 1.5ml of air and lock*

Figure 6: Continue to insert PAC slowly whilst watching waveform to guide location
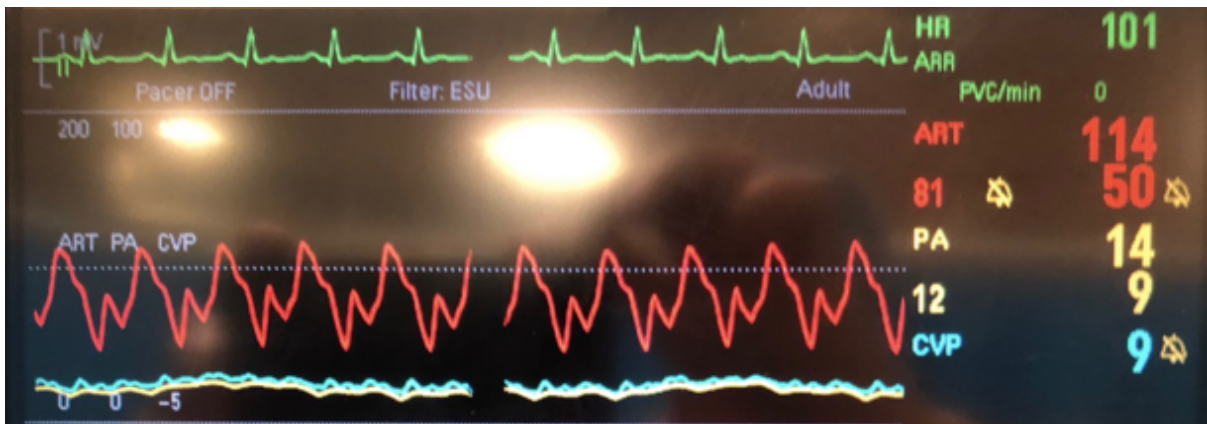
Figure 7: Right Atrium

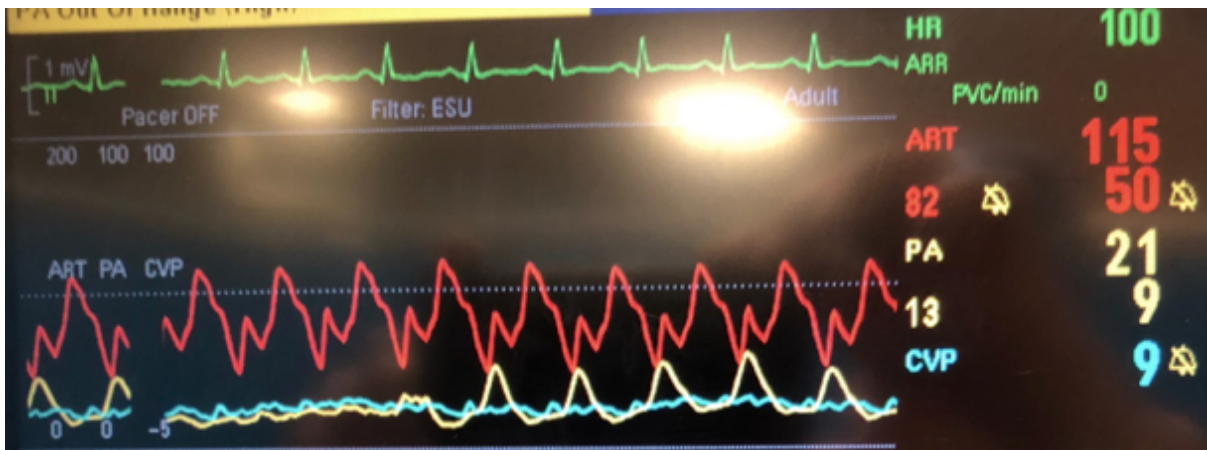*Figure 8: Right atrium into right ventricle*
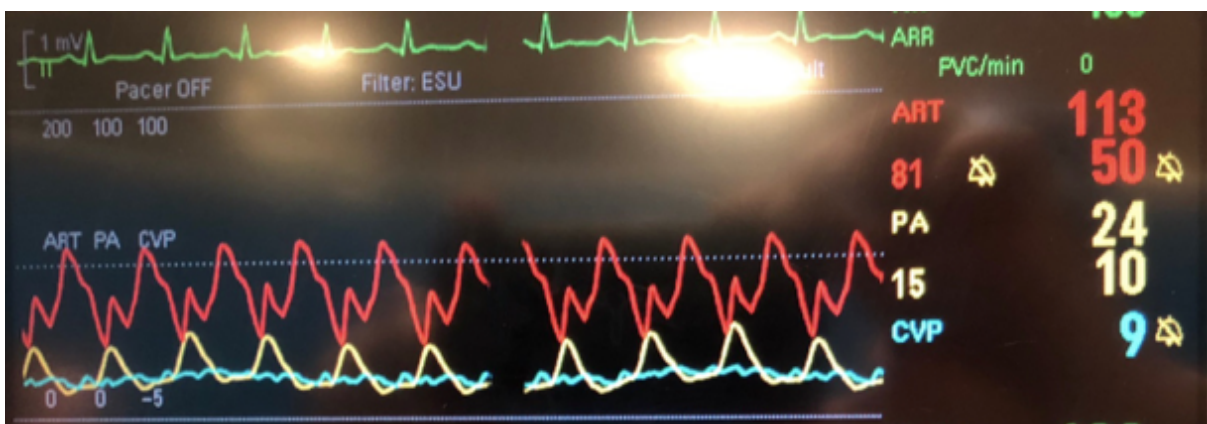

Figure 9: Right ventricle

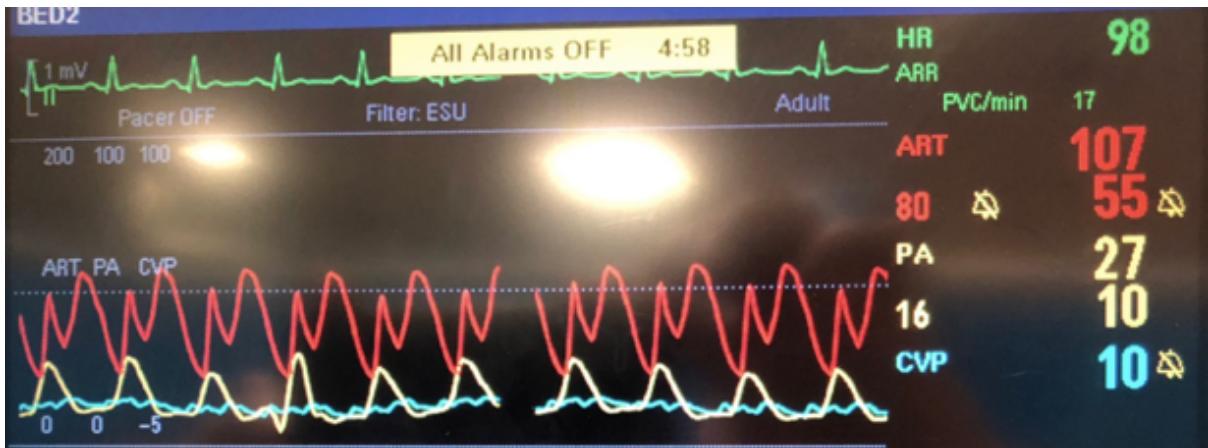*Figure 10: Right ventricle*
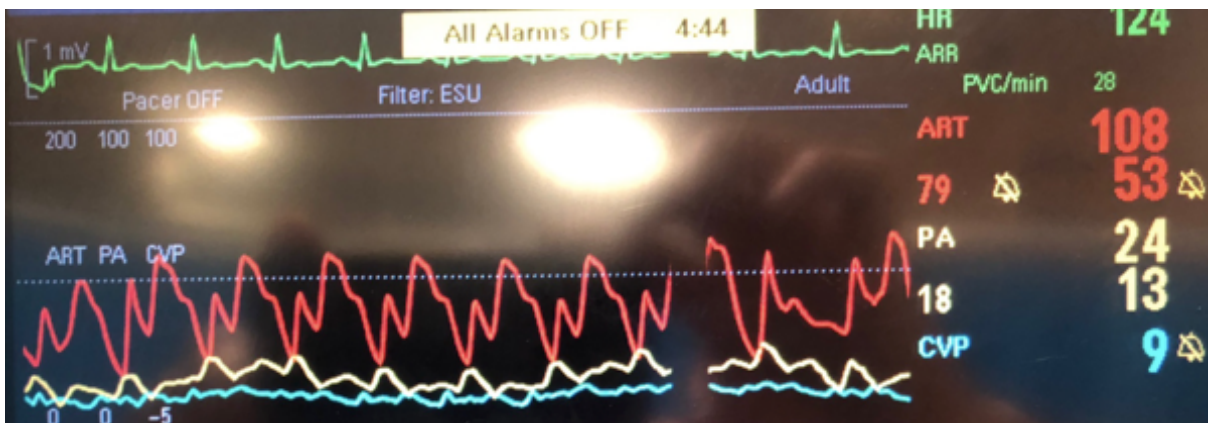

Figure 11: Pulmonary artery
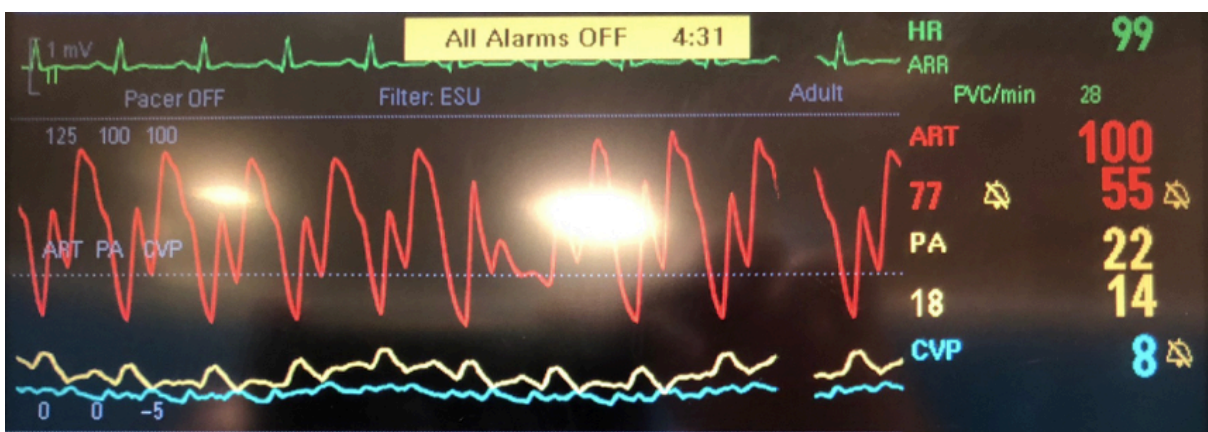

Figure 12: Pulmonary artery
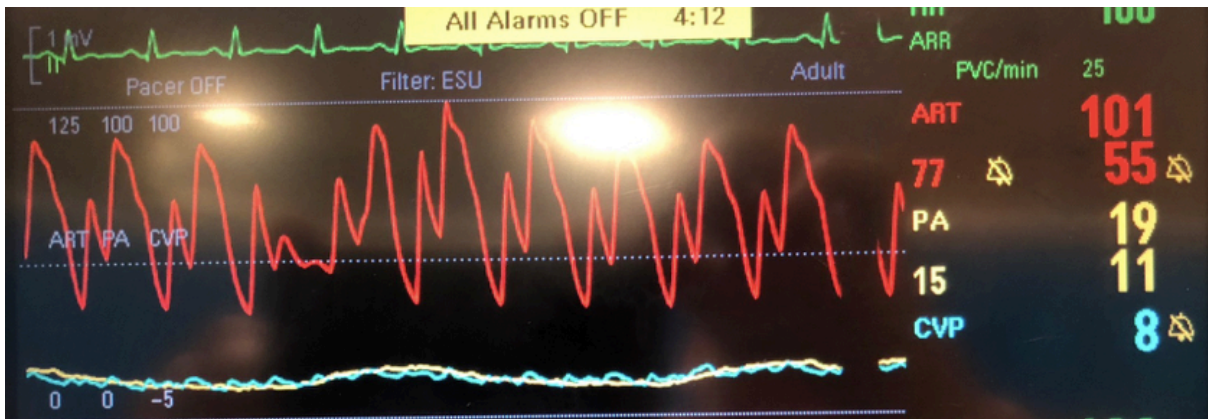
Figure 13: Pulmonary capillary wedge

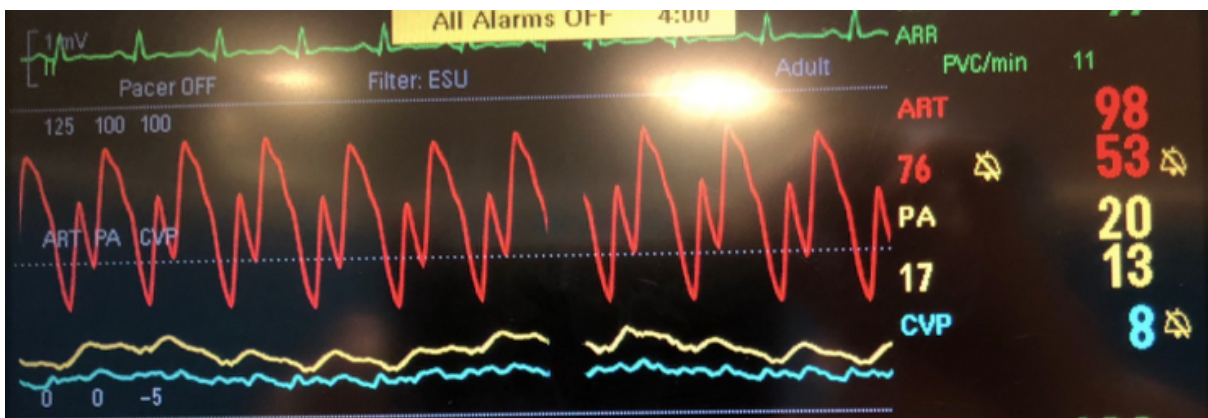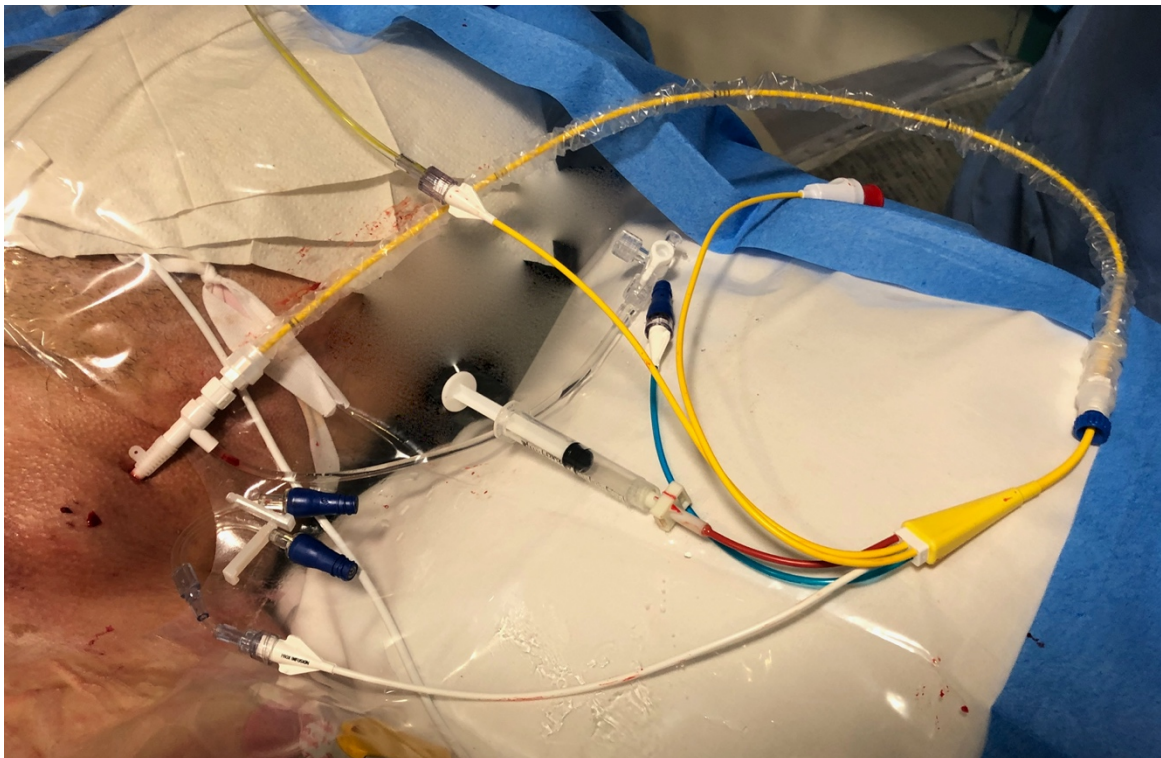*Figure 14: Balloon down, return of pulsatile blood flow*

Figure 15: Deflate balloon and lock tap. Note length of line, lock and secure

Finally confirm position with CXR and check for knotting.

If encountering difficulty with insertion deflate balloon and withdraw and start again.
The right atrium is normally 15-20cm from insertion site when placed in RIJ.

Interpreting the Waveform

Ref: https://slideplayer.com/slide/3835596/
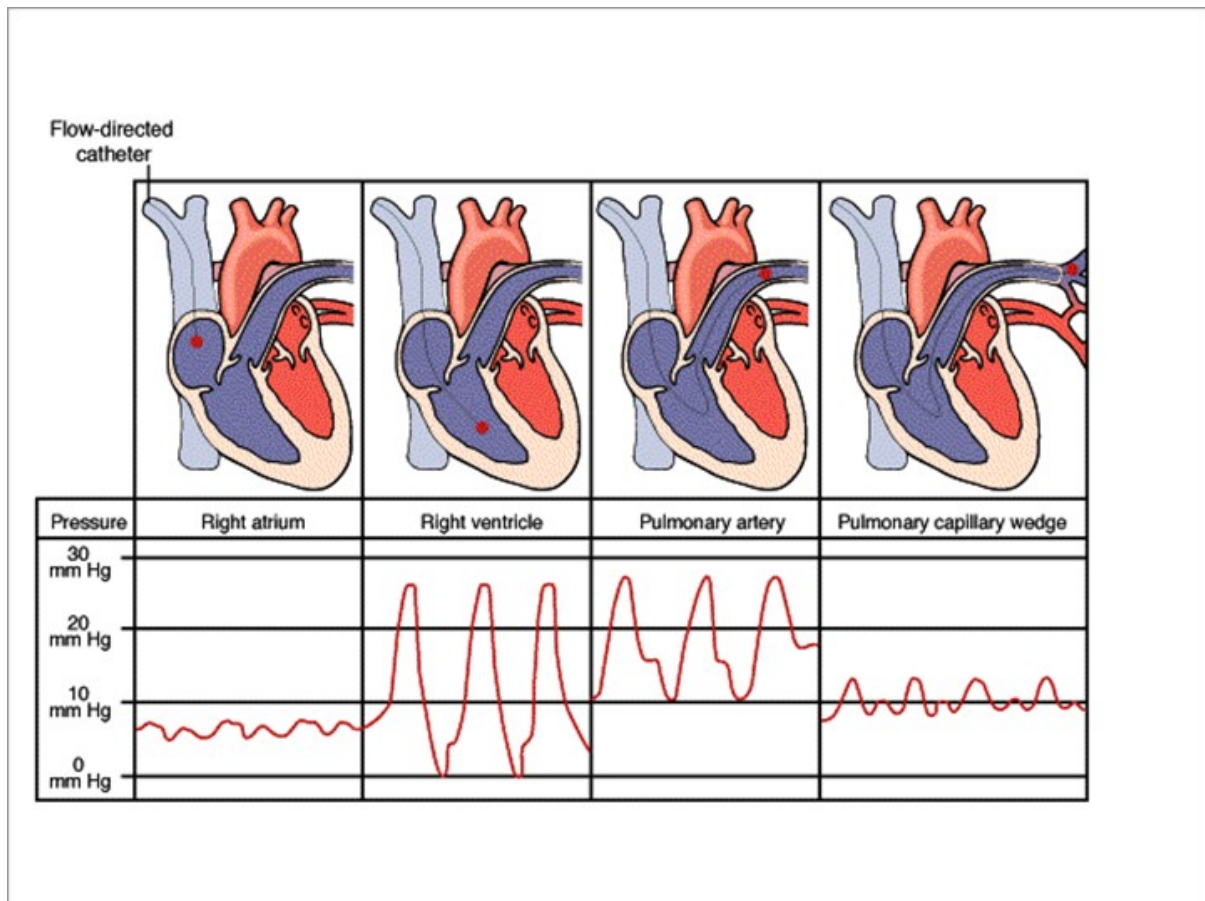
CO output monitoring

CO is measured by the principle of thermodilution. Water of a known volume and temperature is injected into the right atrium where its mixes with blood and travels through the right ventricle to the pulmonary artery where a thermistor measures the change in temperature. A computer uses the Steward-Hamilton equation to calculate CO.

Ensure transducer is at the height of the right atrium and zeroed.
With a PAC compatible line, quickly inject 10ml of ice cold 0.9% NaCl into the proximal injectant port, when monitor instructs you to do so allow the temperature to plateau in between injections. Do this three times, this allows an average to be taken and any anomalous results can be excluded.

Measured Values	Derived Values
Cardiac output	Stroke volume (SV)
Cardiac index	SV index
SvO2	Systemic vascular resistance(SVR)
Central venous pressure	SVR index
Pulmonary artery pressure	Pulmonary vascular resistance(PVR)
Pulmonary artery wedge pressure	PVR index
Temperature	RV ejection fraction
	RV end-diastolic vol
	LV stroke work index
	RV stroke work index
	Oxygen delivery
	Oxygen extraction ratio

Complications

- Arrhythmias on insertion
- Knotting of catheter in right ventricle
- Balloon rupture
- Pneumothorax
- Air emboli
- Arterial puncture
- Pulmonary infarction
- Infection
- RBBB
- Pulmonary artery rupture
- Thrombus

References

Swan HJ, Ganz W, Forrester J, Marcus H, Diamond G, Chonette D (August 1970). "Catheterization of the heart in man with use of a flow-directed balloon-tipped catheter". *N. Engl. J. Med.* **283** (9): 447–51.

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