CSANZ19
CSANZ New Zealand
Annual Scientific Meeting
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CSANZ
Cardiac Society of Australia and New Zealand

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Right Heart Studies: All you need to know...

A Aitken

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Right Heart Studies: Introduction

- Indications
- Equipment required for a Right Heart Study
- Interpretation of waveforms / measurements
  - Normal and abnormal
- Case Example

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Historical Trends

- Advent of non-invasive diagnostic tools
- Cardiac catheterization / RHS used less often
- Often reserved for most complex cases
- Information gathered may be key to determining
  - Operability
  - Management strategies
- Complementary info to non-invasive studies

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Right Heart Studies : Indications

- Assessment of severity of valve disease
  - Especially mitral valve disease
- Pulmonary hypertension
  - Diagnosis confirmation
  - Information re aetiology
  - Prognostic information
- Congenital heart disease
- Myocardial / pericardial disease
  - Eg restrictive CM vs constrictive pericarditis
- (Critical care setting)

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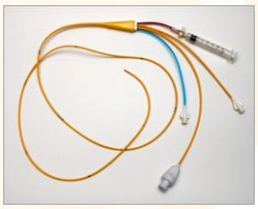
Equipment : S/Ganz Catheter

- 7F system (5F also)
- Yellow – distal port for pressure assessment
- Blue – proximal port for C.O. assessment
- Connector for thermistor for C.O.
- Syringe to inflate balloon



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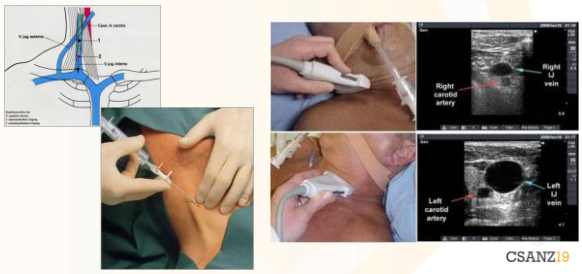
Access Sites : I.J.



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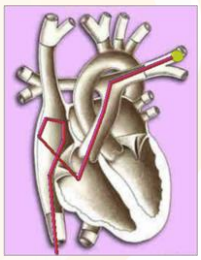
Access Sites : Brachial / Femoral



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Comparison of Sites

	Advantages	Disadvantages	Complications
R Int Jugular Vein	Proximity to heart Easier PA access	Difficult access (U/S)	Carotid a puncture Pneumothorax
L Subclavian Vein	Easier PA access	Difficult access Incompressibility	Pneumothorax Haemothorax
R Antecubital Vein	Safe	Variable anatomy Restricts steerability	Phlebitis
R Femoral Vein	Easy access Convenient for LHC	Difficult PA access Immobility after	Haematoma

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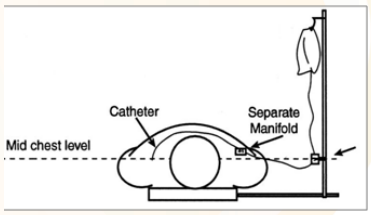
Transducer Position



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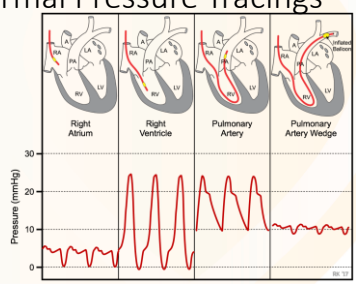
Normal Pressure Tracings



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Case 1: Ms A 34F

- 2 years of increasing SOB
- ECHO suggestive of pulmonary HT
  - Enlarged RA and RV with reduced RV function
  - Mild+ TR with RVSP approx. 80mmhg
  - Left heart looks normal
- Referred for Right heart study (What other tests should she have had ?)
  - RBV approach 5F SG catheter
  - Single transducer
  - ABG sent from SVC / MPA and Aorta (radial a or oximeter)

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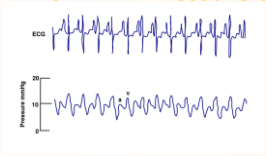
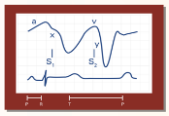
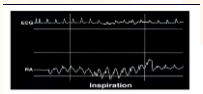
MS A : RA Pressure tracings : mean 10mmHg



- a wave
  - atrial systole
- c wave
  - Tricuspid valve closure
- x descent
  - Atrial relaxation
- v wave
  - Filling during ventricular systole
- y descent
  - Fall in atrial pressure with onset of diastole





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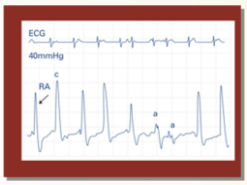
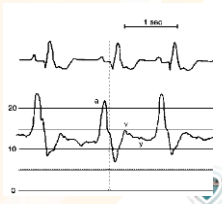
RA Pressure tracings:





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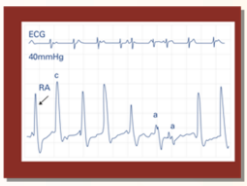
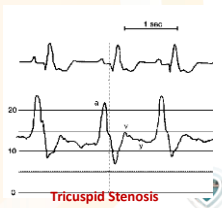
RA Pressure tracings:



Cannon waves in AV block



Tricuspid Stenosis

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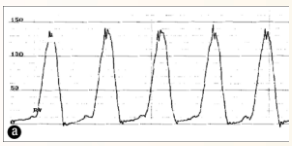
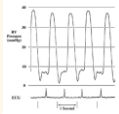
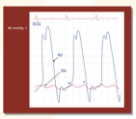
RV Pressure Trace : RVSP 120/15





- RVEDP measured after 'a' wave
- Ringing (underdamping)



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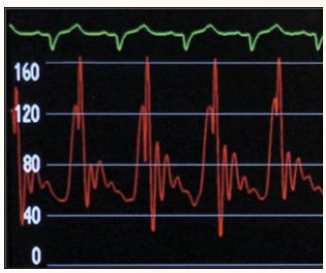
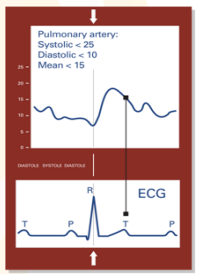
PA Pressure Tracing : What is value ?





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PA Pressure Tracing :

- Underdamping / whip artefact
- Requires correction
  - manipulation by physiologist
  - improve tracing

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Principles of accurate measurements

- Shortest tubing (avoid manifolds)
- Regular flushing of catheters
- Stability of catheter (avoid whip artefact)
- Larger catheter (7F vs 5F) if poor quality
- Regular zeroing
- Calm , fastidious approach !

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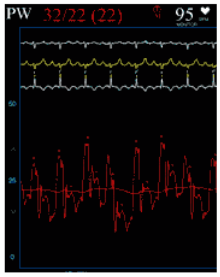
PCWP Tracing : Mean PCWP 22 mmHg

What is implication of this result ?
What would you do next ?



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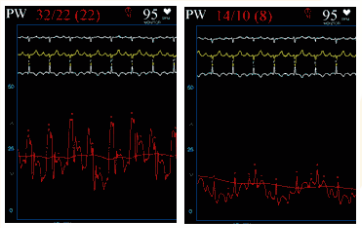
True Wedge 8mmHg



"Underwedged" True wedge

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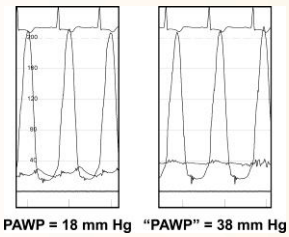
Spurious Recordings



PAWP = 18 mm Hg "PAWP" = 38 mm Hg

- Over-wedging / damping
- Partially deflate balloon
- Re-advance
- Confirm with O_2 saturation
  - > 95%
- May require larger bore catheter

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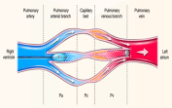
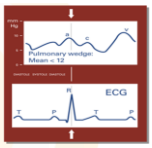
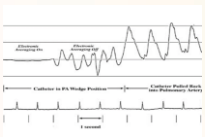
PAWP Trace

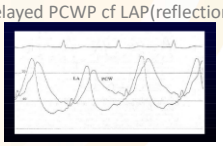




Balloon Wedging



Delayed PCWP cf LAP(reflection)



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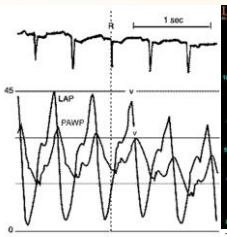
LA and PAWP Tracing in MR / MS



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How to get a good wedge

- Get it in the right position
  - Preferably basal lung segments
- Measure at end expiration
- Serial measurements
- If looks like PA trace ensure balloon fully inflated / retry
- If looks damped withdraw catheter / re-inflate balloon with less air and retry
  - May require larger catheter

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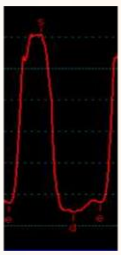
What if you can't get a wedge ?



- LVEDP measure
- LVEDP < LAP
  - MR /MS
- LVEDP > LAP
  - Acute AR
  - Noncompliant LV
    - Premature closure of MV

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Ms A : Measurements

mRAP	RVSP	MPAP	PCWP	(LVEDP)
10	120	80	8	11

- What else is needed ?

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Ms A : Measurements

mRAP	RVSP	MPAP	PCWP	(LVEDP)
10	120	80	8	11

SVC sat	MPA sat	Ao Sat
67%	68%	98%

- Assessment of Cardiac Output
  - Fick
  - Thermodilution (7F)
- Assessment of PVR
- Assessment of vasoreactivity
  - Iloprost neb
  - (NO)

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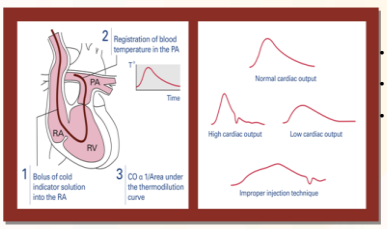
Cardiac Output: Thermodilution



- Inaccurate in low C.O. and severe TR
- Intracardiac shunts affect shape of curve
- Average of 3-5 measurements
  - 3 values within 15%

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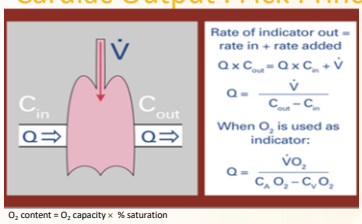
Cardiac Output : Fick Principle



- O_2 content = O_2 capacity × % saturation
- O_2 capacity = [Hb] (130)× 1.36 (= 177)
- VO_2 (oxygen consumption) measured (direct) or assumed (assumed 200 ml/kg/m2)
- **CARDIAC INDEX – cardiac output divided by BSA**

- Time consuming
- Saturations inaccuracies
  - may repeat samples
- Less accurate with high C.O.

$$Qs = \frac{200}{177*0.98 - 177*68}$$

$$= \frac{200}{53}$$

$$= 3.77\ l/min$$

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Pulmonary Vascular Resistance

- Pressure drop across pulm. circulation per unit of flow in specified time period
- PVR = $\frac{\text{mPAP} - \text{mLAP(PAWP)}}{\text{Qp}}$
- SVR = $\frac{\text{MAP - mRAP}}{\text{Qs}}$
- Result is in Wood Units
  - normal PVR ≤ 3 woods units
  - WU × 80 = Dynes/sec/cm^5

- PVR = $\frac{80-8}{3.77}$ = 19 W.U.
- = 1527 dynes/sec/cm^5

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Ms A – results /significance

	RAP	RVSP	mPAP	PCWP	LVEDP	PA sat	SVC sat	Ao Sat	C.O.	PVR
Rest	10	120	80	8	11	68	67	98	3.77	19
Iloprost	8	80	50	10		68		98	3.77	11

- Severe PAH with some vasodilator responsiveness
- No evidence of left heart disease
- Clear mandate for trial of pulmonary vasodilator therapy
- Prognostic factors
  - RAP / SVO_2 / Cardiac Index

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Const. Pericarditis vs Restrictive Cardiomyopathy

- Clinical history
- Exam findings unlikely to help
  - pericardial knock vs 3rd HS !
- ECG / CXR / BNP may help
- ECHO
  - Increased resp variation in vent filling velocity in CP
  - E' < 8 RCM >12 CP (but generally measures between these !)
- CT/MRI for pericardial thickening / scar / interdependence

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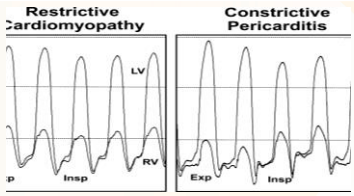

- Multiple diagnostic criteria assessed
- Best is intraventricular dependence in constrictive pericarditis
  - With inspiration LV pressure falls as RV pressure rises
  - Due to :
    - dissociation of intrathoracic and intracardiac pressures
    - ↓ PCWP reflecting intrathoracic pressure but LV shielded from this

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Complications of RHC

- Associated with central line placement
  - Haematoma 1:200 (carotid a. puncture)
  - Pneumothorax 1:500
  - Temporary hoarseness (LA around rec laryngeal n)
- Associated with PAC Insertion
  - Serious arrhythmia 1:1000
    - Mainly transient (treat atrial with overdrive pacing)
  - Pulmonary infarction / rupture rare (0.03%)
    - Inflation of balloon while wedged
  - RV perforation rare

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Conclusions

- RHS not quite a forgotten art
  - Clear ongoing rationale for procedures
  - Low risk
- Importance of scrupulous technique
- Ensure all important information collected
  - Plan procedure
  - Pressures / cardiac output / vasodilator challenge if appropriate
  - Ensure question posed is answered....

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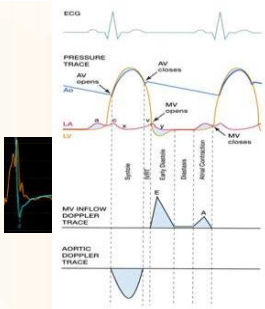
LVEDP

- Same as atrial 'a' wave
- Peak at end of diastole assoc. with atrial contraction
- 3 phases of LV filling



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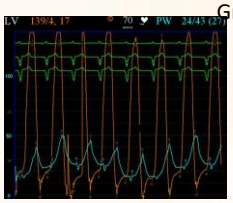
Left Heart Pressure Examples

- Mitral Stenosis
- Assessment of Mean Gradient



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LV and PAWP Tracings

- MR with no MS
- MR and MS

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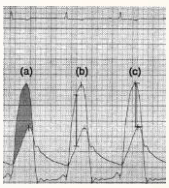
LV – AO Gradients



- (a)
  - Mean AoV gradient
- (b)
  - ECHO max gradient
- (c)
  - Peak-peak withdrawal gradient

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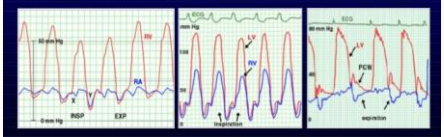
Right Heart Catheterization
Restrictive Cardiomyopathy



- Prominent y descent
- Normal respiratory variation
- Square root sign
- RVSP > 55 mm Hg
- RVEDP / RVSP < 1/3
- LVED-RVED > 5 mm Hg
- RV-LV interdependence absent
- Prominent y descent
- Lack of variation in early PCW-LV gradient

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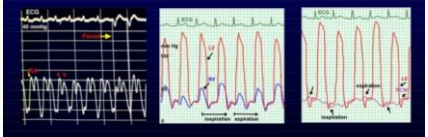
Right Heart Catheterization
Constrictive Pericarditis



- Prominent x and y descents
- Equal a and v waves
- M wave morphology
- Square root sign
- RVSP < 55 mm Hg
- RVEDP / RVSP > 1/3
- LVED-RVED < 5 mm Hg
- RV-LV interdependence
- Prominent y descent
- Variation in early PCW-LV gradient

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Right Heart Catheterization
Right vs Left Ventricular Pressure

	Constrictive Pericarditis	Restrictive Cardiomyopathy
End diastolic pressure equalization (LVED-RVED)	≤ 5 mm Hg	> 5 mm Hg
Pulmonary artery pressure	< 55 mm Hg	> 55 mm Hg
RVEDP / RVSP	> 1/3	≤ 1/3
Dip-plateau morphology	LV rapid filling wave > 7 mm Hg	LV rapid filling wave ≤ 7 mm Hg
Kussmaul's sign	No respiratory variation in mean RAP	Normal respiratory variation in mean RAP

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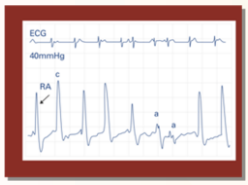
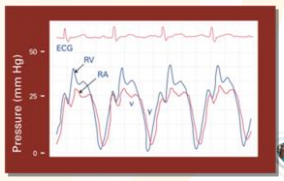
RA Traces

Cannon waves



Tricuspid Regurgitation



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