HAEMODYNAMIC IN THE CATH LABORATORY

INTRO TO BASICS

BY

NOOR FADZLY ALIAS
CARDIOVASCULAR TECHNOLOGIST
NCL Department
National Heart Institute Kuala Lumpur
OUTLINE

- INTRODUCTION
- ROLES OF HAEMODYNAMIC MONITORING
- PURPOSE
- FACTORS INFLUENCES
- TRANSDUCER
- HAEMODYNAMIC DATA
INTRODUCTION

- Haemodynamic monitoring plays an important role in catheterization laboratory. It works hand in hand with other modalities such as fluoroscopic machine.
- Without functioning of hemodynamic monitoring machine, catheterization procedure should not be performed as it may cause more harm to the patient than the benefits.
THE ROLE OF HEMODYNAMIC MONITORING

Among the roles that it plays in standard cardiac catheterization laboratory are:-

1. To be used as a tool to diagnose various cardiovascular diseases such as pericardial diseases, Valvular diseases, congenital heart diseases etc.

2. To monitor current haemodynamic status while the diagnostic or interventional procedures is being performed as well as to assess the successful or effectiveness of the interventions e.g. PTMC, PTBV etc.

3. To assess ventricular function in various cardiac situation eg. LVEDP, DP/DT etc.
Purpose

• Measure intracardiac pressures
• assess intracardiac blood flow
• assess ventricular function
• determine cardiac anatomy
• assess valvular function
• assess pulmonary and systemic circulatory systems

• Intracardiac biopsy
• Intravascular Ultrasound
FACTORS INFLUENCE HEMODYNAMIC

- CO (Cardiac Output)
- Circulating Fluid Volume
- Respiration
- Vascular Diameters & Resistance
- Blood Viscosity
HEMODYNAMIC MONITORING EQUIPMENT

- transducer
- Monitor
- fluid filled catheter
- tubing and flush system
PRESSURE TRANSDUCER

- Transducer can be defined as a device that converts one form of energy to another, in this case pressure energy to electrical signals.
- There are several types of transducer such as reusable transducer, disposable transducer and catheter tip transducer.
- Generally these transducers use electrical strain gauge and employ the principle of the Wheatstone bridge. (Baim 2000)
- Transducers must be properly balanced and zeroed at the mid chest level to get accurate pressure measurements.
PRESSURE TRANSDUCER-CONT’

- Improper balancing the electrical strain gauge will cause erroneous to the measurements.
- Too low the transducer positions will cause the pressure to be higher than actual situation and at the opposite way too high positions will cause lower than actual pressure.
- Placement of 10 cm higher than the patient’s mid-chest will cause the recorded pressure 7.4 mmHg lower than the actual. (Todd’s CV)
PRESSURE TRANSUDER- CONT

- Zero referencing and leveling
  - Most authors suggest that the transducer must be zero at mid chest level.
  - If patient is not able to lay supine for any reasons such as dyspenic, zero referencing should be taken at Mid-axillary line and 4th intercostal space.
LEVELING THE TRANDUCER
# Troubleshooting Pressure Monitoring Systems

<table>
<thead>
<tr>
<th>Problems</th>
<th>Possible Causes/Solutions</th>
</tr>
</thead>
</table>
| No waveform               | Check power supply  
Check the pressure range setting on the monitoring equipment  
Check zero reference and calibration of the equipment  
Check for loose connection in the pressure-monitoring line  
Check to be certain that stopcocks are not turned off to the patient  
Be certain that the connecting tubing is not kinked or compressed.  
It is possible that the catheter is occluded or has moved out of the vessel. If this is suspected, try to aspirate blood from the line.  
Note: Fast flushing the line may dislodge a loose clot and cause distal embolization.  
Never use a syringe to aggressively flush any haemodynamic monitoring line. |
| Artifact                  | Check for electrical interference  
Check for patient movement  
Catheter whip may be the problem (pulmonary artery catheters)  
Do dynamic response test to determine underdamping  
Use alternative method of measurement when possible, such as cuff arterial blood pressure monitoring |
| Waveform drifting         | Temperature change of IV solution (new flush bag hung) or environmental temperature change.  
Rezero the system. |
<table>
<thead>
<tr>
<th>Problems</th>
<th>Possible Causes/Solutions</th>
</tr>
</thead>
</table>
| Unable to flush line with the continuous flush system | Check stopcocks and tubing for kinks  
Check to see that the pressure bag is inflated to the appropriate level  
Reposition catheter to move it away from vessel walls or to remove catheter kinks  
Aspirate with a syringe (do not apply excessive force to aspirate) |
HEMODYNAMIC:

The word hemodynamic is derived from two Greek words meaning blood and power.
Meaning literally “Blood movement” is the study of blood or the circulation.
Are the forces which circulates blood through the body.

“Terms used to describe the intravascular pressure & Flow that ours when the heart muscle contracts and pumps blood throughout the body.”
BLOOD CIRCULATION

1. Superior vena cava
2. Inferior vena cava
3. Right atrium
4. Tricuspid valve
5. Right ventricle
6. Pulmonary valve
7. Pulmonary artery (to the lungs)
8. Pulmonary veins (from the lungs)
9. Left atrium
10. Mitral valve
11. Left ventricle
12. Aortic valve
13. Aorta

From the lungs (to left atrium)

To the lungs

Oxygenated blood

Unoxygenated blood

Copyright 1999, Howstuffworks.com, Inc.
WAVEFORM IN THE HEART

**LT Heart Pressure**
- LA
- LV
- AO

**RT Heart Pressure**
- RA
- RV
- PA
- PCW
NORMAL RIGHT- AND LEFT- HEART PRESSURES
WAVEFORM
Left Heart Catheterisation

- Aorta
- Left ventricle
Aortic Pressure

Peak measurement

Dichrotic notch

Anachrotic Notch

AORTA  Normal systolic pressure = 120 mmHg (100 - 140)

Normal diastolic pressure = 70 mmHg  (60 - 90)
Isovolumetric contraction

Peak measurement

LEFT VENTRICLE
Normal systolic pressure = 120 mmHg (100-140)
Normal diastolic pressure = 0-10 (pre),
0-20 (post) mmHg
Right heart catheterisation

- RA
- RV
- PA
- PCWP
Right Atrial Pressure

RIGHT ATRIUM normal mean pressure < 5mmHg
RIGHT VENTRICLE  NORMAL SYSTOLIC PRESSURE < 25 MMHG
NORMAL DIASTOLIC PRESSURE < 5 MMHG
Pulmonary Artery Pressure

Peak measurement

Dichrotic notch

**PULMONARY ARTERY**
- Normal systolic pressure < 25 mmHg
- Normal diastolic pressure < 10 mmHg
- Normal mean pressure < 15 mmHg
RV <25/<5
LV <130/<10
PA
<25/<10
Mean 15

Ao
<130/<85
Mean 100
# Normal Pressures and Vascular Resistances

<table>
<thead>
<tr>
<th>Pressures</th>
<th>Average (mm Hg)</th>
<th>Range (mm Hg)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Right atrium</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a wave</td>
<td>6</td>
<td>2-7</td>
</tr>
<tr>
<td>v wave</td>
<td>5</td>
<td>2-7</td>
</tr>
<tr>
<td>mean</td>
<td>3</td>
<td>1-5</td>
</tr>
<tr>
<td><strong>Right ventricle</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>peak systolic</td>
<td>25</td>
<td>15-30</td>
</tr>
<tr>
<td>end-diastolic</td>
<td>4</td>
<td>1-7</td>
</tr>
<tr>
<td><strong>Pulmonary artery</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>peak systolic</td>
<td>25</td>
<td>15-30</td>
</tr>
<tr>
<td>end-diastolic</td>
<td>9</td>
<td>4-12</td>
</tr>
<tr>
<td>mean</td>
<td>15</td>
<td>9-19</td>
</tr>
<tr>
<td><strong>Pulmonary capillary</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>wedge</td>
<td></td>
<td></td>
</tr>
<tr>
<td>mean</td>
<td>9</td>
<td>4-12</td>
</tr>
<tr>
<td><strong>Left atrium</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a wave</td>
<td>10</td>
<td>4-16</td>
</tr>
<tr>
<td>v wave</td>
<td>12</td>
<td>6-21</td>
</tr>
<tr>
<td>mean</td>
<td>8</td>
<td>2-12</td>
</tr>
<tr>
<td><strong>Left ventricle</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>peak systolic</td>
<td>130</td>
<td>90-140</td>
</tr>
<tr>
<td>end-diastolic</td>
<td>8</td>
<td>5-12</td>
</tr>
<tr>
<td><strong>Central aorta</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>peak systolic</td>
<td>130</td>
<td>90-140</td>
</tr>
<tr>
<td>end-diastolic</td>
<td>70</td>
<td>60-90</td>
</tr>
<tr>
<td>mean</td>
<td>85</td>
<td>70-105</td>
</tr>
<tr>
<td>Right Heart</td>
<td>Pressures in mmHg</td>
<td>Left Heart</td>
</tr>
<tr>
<td>-------------</td>
<td>-------------------</td>
<td>------------</td>
</tr>
<tr>
<td>PAW =</td>
<td>12, 12, 10 (a, v, m)</td>
<td>LA =</td>
</tr>
<tr>
<td>PA =</td>
<td>25/10, 15 (s/d, m)</td>
<td>AO =</td>
</tr>
<tr>
<td>RV =</td>
<td>25/0, 5 (s/bd, ed)</td>
<td>LV =</td>
</tr>
<tr>
<td>RA =</td>
<td>5, 5, 5 (a, v, m)</td>
<td></td>
</tr>
</tbody>
</table>
OXYGEN SATURATIONS IN THE HEART

- **Oxygen Saturation:**
  Oxygen saturation measures the percentage of hemoglobin binding sites in the bloodstream occupied by oxygen.
OXYGEN SATURATION

Red blood cells contain several hundred hemoglobin molecules which transport oxygen.

Hemoglobin molecule

Heme

Oxygen binds to heme on the hemoglobin molecule.
## Normal O2 saturation & Pressures (Estimation)

<table>
<thead>
<tr>
<th>Chamber</th>
<th>Pressures mmHg</th>
<th>O2 saturation %</th>
</tr>
</thead>
<tbody>
<tr>
<td>SVC</td>
<td></td>
<td>70</td>
</tr>
<tr>
<td>IVC</td>
<td></td>
<td>75</td>
</tr>
<tr>
<td>RA</td>
<td>Mean &lt; 5</td>
<td>73</td>
</tr>
<tr>
<td>RV</td>
<td>25/5</td>
<td>73</td>
</tr>
<tr>
<td>PA</td>
<td>25/9 mean 15</td>
<td>73</td>
</tr>
<tr>
<td>PV</td>
<td></td>
<td>95</td>
</tr>
<tr>
<td>LA</td>
<td>Mean &lt; 12</td>
<td>99</td>
</tr>
<tr>
<td>LV</td>
<td>120/12</td>
<td>97</td>
</tr>
<tr>
<td><strong>Ascending Aorta</strong></td>
<td>120/70 mean 85</td>
<td>95</td>
</tr>
<tr>
<td><strong>Descending Aorta</strong></td>
<td>120/70 mean 85</td>
<td>95</td>
</tr>
</tbody>
</table>
RECAP

RA (5 / 5 / 5)
LA (12 / 12 / 10)
PCWP (12 / 12 / 10)
RV (25 / 0 / 5)
LV (120 / 0 / 10)
PA (25 / 10 / 15)
AO (120 / 70 / 85)
CONCLUSION

- Accurate Hemodynamic measurements is crucial as it will affect the patient prognostic and management strategy. Error caused by poor in setting up the system or transducer drift may lead to morbidity or mortality to the patient. Therefore meticulous in setting up, zero balanced, leveling and calibration in needed.
Thank You!
mean is the formula: \[ \text{mean } AO = \frac{systole + (2 \times \text{diastole})}{3} \]
LA pressure - How do you measure?

LA pressure = PCW pressure = LV diastolic pressure
QUESTION ???
Types of coronary catheter DAMPING
CORRECTLY MATCHED ANSWERS ARE:

1. Ventricularization: Arterial pressure mimics LV with exception of a lower systolic and higher diastolic. (Associated with left main stenosis)

2. Reduced pressure damping: Pressure falls off as the tip is occluded and does not transmit pressure to the transducer.

3. LV (retrograde across valve): Catheter advanced across Aortic valve into LV. While this is NOT a form of damping, it commonly occurs while attempting to cannulate the coronary ostium. Dangerous ventricular arrhythmias can result if it goes unnoticed.

4. Reduced high frequency response (contrast): Phasic pressure is smoothed out as the catheter lumen size is reduced due to clot, partial occlusion, or viscous fluid such as contrast or blood in the lumen. These damped waveforms looks as if you had activated the "mean" switch on the recorder.
AO pressure during insertion into coronary artery
"Damping"

Coronary artery damping restored
"Care should be taken to observe arterial pressure from the tip of the guide catheter to be sure that 'damping' does not occur. If either 'damping' or 'ventricularization' occurs, the balloon should be advanced quickly across the stenosis and the guiding catheter withdrawn immediately to a more proximal or ostial position to reestablish adequate coronary flow."
Monitoring ECG and coronaries