

Hemodynamic Profile Analysis: Making Sense of the Numbers



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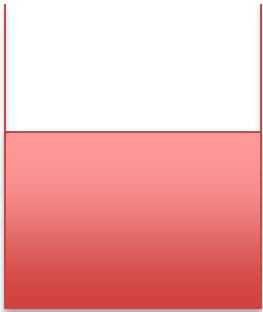
- Review of cardiac output determinants (Preload, Afterload, Contractility, Perfusion)
- Discussion of the meaning of abnormal values
- Common hemodynamic profiles
- Case study practice with systematic analysis of hemodynamic profiles using case studies

Parameter	Hemodynamic Value	
CO	3.0	l/min
Cardiac Index (C.I.)	1.8 l/min/m ²	l/min/m ²
Heart Rate (H.R.)	119	min
Right atrial pressure (RAP)	8	mmHg
Wedge	22	mmHg
Left Ventricular Stroke Work Index (LVSWI)	10.3	g/m ² /beat
Right Ventricular Stroke Work Index (RVSWI)	2.7	g/m ² /beat
Systemic Vascular Resistance (SVR)	1800	Dynes-sec/cm ⁻⁵
Pulmonary Vascular Resistance (PVR)	240	Dynes-sec/cm ⁻⁵
Pulmonary Artery Pressure (PAP)	42/26	mmHg
Blood Pressure (B/P)	88/48	mmHg

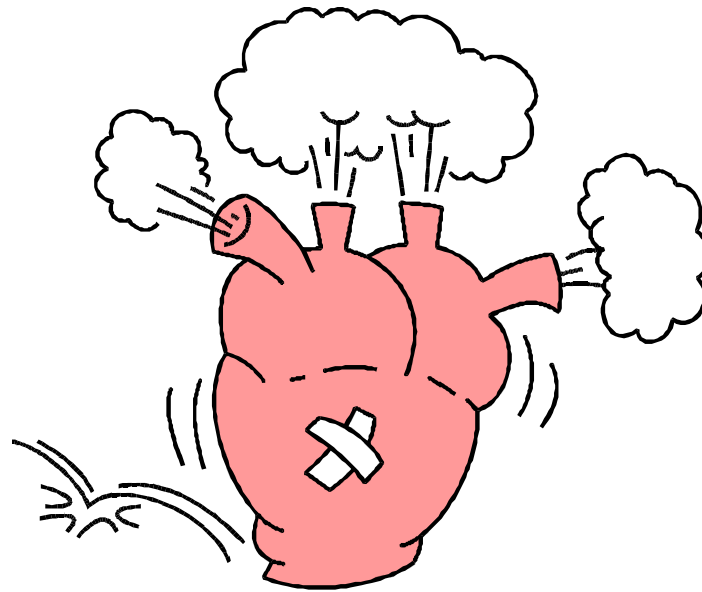
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Determinants of Cardiac Output

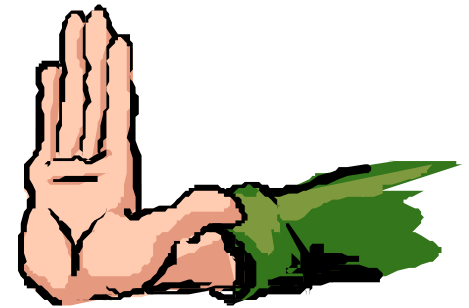
Heart rate



Preload



Contractility



Afterload



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PRELOAD

Preload

- The amount of stretch in the ventricles at the end of diastole
- Is related to volume, compliance



Left Side

- Wedge (normal= 6-12 mmHg)

Right Side

- Jugular Venous Distention (JVD)
- CVP/RAP (normal= 0-7 mmHg)

High Wedge

- Seen in positive pressure ventilation
- Hypervolemia
- Mitral valve malfunction
- LV failure
- Cardiac tamponade

Low Wedge

- Hypovolemia
- vasodilation

RAP/CVP Abnormals

High	Low
Hypervolemia	Vasodilation (i.e. with venous vasodilators such as nitrates and morphine)
Tricuspid dysfunction	Hypovolemia
Right Ventricular (RV) failure	
Pulmonary hypertension	
Positive Pressure Ventilation	



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Afterload

- The amount of resistance the ventricle has to overcome to eject the blood
- Affected by volume, cardiac function and vascular impedance



Numbers related to Afterload:

Left side

Systemic Vascular Resistance (SVR)

Normal= 800-1200 dynes-sec/cm⁻⁵

Right Side

Pulmonary Vascular Resistance (PVR)

Normal= <250 dynes-sec/cm⁻⁵

What do the abnormal afterload numbers mean?

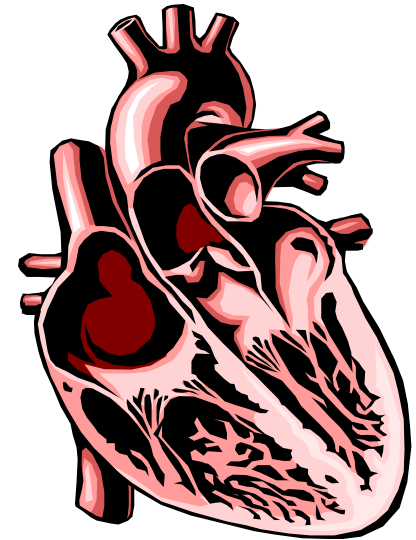
Parameter	High	Low
PVR	Pulmonary hypertension (i.e. pulmonary embolism)	Broncho-vasodilation
SVR	Vasoconstriction hypertension	Vasodilation



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CONTRACTILITY

- The contractile force of the ventricles
- Ability to shorten muscle fibres without altering length of muscle or preload
- Sympathetic nervous system
 - catecholamines increase
- Metabolic states
 - acidosis decreases
- Medications
- Affected by damage (ie MI) or disease (ie cardiomyopathy)



- **Ejection Fraction (E.F.)** normal=60-80%
- **Left Ventricular Stroke Work Index (LVSWI)**
normal=50-62 g/m²/beat
- **Right Ventricular Stroke Work Index (RVSWI)** normal = 5-10 g/m²/beat

What do the abnormal contractility values mean?

Parameter	High	Low
LVSWI	Inotropic effect (i.e. dopamine)	MI Beta Blockers Heart failure
RVSWI	Compensatory response	Cardiogenic Shock Fluid Overload

Common Hemodynamic Profiles

Profile	Expected Findings	
	High	Low
Hypovolemic Shock	HR, SVR	C.O., C.I., RVSWI, LVSWI, RAP, Wedge
Cardiogenic Shock	Wedge, RAP, HR, SVR	C.I., C.O., LVSWI, RVSWI
Pulmonary Hypertension	PAd (PAd 3-5mmHg > than wedge), PVR	
Septic Shock (early)	C.I./C.O., HR	RAP, PAP, Wedge, SVR



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Hemodynamic Profile Systematic Approach

Step 1

Analyze the numbers in the profile
(i.e. high, low or normal)

Step 2

Using the **'grid'** approach, discuss the values in terms of preload, afterload, contractility and perfusion.

The GRID Approach

Perfusion

C.O./C.I.
HR
MAP
PAP

Preload

RAP/CVP
Wedge

Contractility

LVSWI/RVSWI
EF

Afterload

SVR
PVR



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PERFUSION

- How well the tissues are being oxygenated.
- Measured by:
 - Clinical assessment (i.e. colour, LOC)
 - C.O. normal= **4.0-8.0** litres/min
 - /C.I. normal **2.5-4.0** litres/min/m²
 - HR normal **60-100**/beats/min
 - MAP normal **70-105**mmHg
 - B/P

Step 3

Discuss potential causes of this hemodynamic disturbance (i.e. septic shock)

Step 4

Discuss expected treatment for this profile.



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Practice

- Mr. S, 52 years old
- Admitted to the ICU after surgery for repair of hemothorax after a gunshot wound
- Massive blood loss pre op
- Estimated Blood Loss in OR = 1 litre
- He has had 5 L of normal saline and 2 units of packed cells
- Past medical history= MI 5 years ago, angioplasty 2 years ago

CO 2.8

CI 1.5

HR 129

RAP 1

Wedge 3

LVSWI 13.1

RVSWI 1.8

SVR 2200

PVR 225

PAP 18/6

B/P 80/43

Step 1: Analyze the numbers (high, low or normal?)

Parameter	Analysis
SVR, HR	High
CO, CI, Wedge, PAP, RVSWI, LVSWI, B/P	Low
PVR	Normal

Step 2: Use the grid approach

Perfusion

LOW

(decreased CO/CI,
B/P and increased HR)

Preload

LOW

(decreased
RAP/Wedge)

Contractility

LOW

(decreased
LVSWI/RVSWI)

Afterload

**HIGH (Left
side)**

(increased SVR)



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- This patient is in **hypovolemic shock** and requires fluid resuscitation



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CASE 2

- Mr. J. 44 y.o. transported to a regional ER after having chest pain x 6 hours
- ST elevation V₂- V₆
- History of 2 previous MIs
- Despite fibrinolytic given in ER, he is now hypotensive with an S3 heard at the apex and crackles in lung bases bilaterally
- u.o. has been marginal for last 2 hours



Here are his numbers:

CO 3.0

CI 2.0

HR 119

RAP 8

Wedge 22

LVSWI 10.3

RVSWI 2.7

SVR 2000

PVR 240

PAP 42/26

B/P 80/58

Step 1: analyze the numbers

SVR, PAP,HR, Wedge	high
LVSWI,RVSWI, CO, CI, B/P	low
PVR, RAP	normal

Step 2: Apply Grid Approach

<u>Perfusion</u> POOR	<u>Preload</u> HIGH
<u>Contractility</u> LOW	<u>Afterload</u> HIGH



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- This patient is in **cardiogenic shock**.

- **Expected Treatment?**

Hemodynamic Profile Systematic Review Recap

Step 1: Analyze the numbers

Step 2: Discuss the numbers using the systematic approach

Step 3: What does the profile represent?

Step 4: Expected Treatment



Questions?

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