

HeartWare®

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GL1115 Rev01 1/15

CAUTION: Federal Law (USA) restricts this device to sale by or on the order of a physician. Refer to the "Instructions For Use" for complete Indications for Use, Contraindications, Warnings, Precautions, Adverse Events and Instructions prior to using this device.

CE 0086

HVAD[®] System Patient Management

Optimizing Speed

LVAD speed should be maintained at the minimum level to:

- Attain **satisfactory hemodynamic** support
 - $MAP \leq 80$ mm Hg
 - End organ perfusion (cardiac index >2.2 L/min/m², SVO₂, urine output, creatinine, liver function test)
 - No symptoms of heart failure (wedge, cvp)
- Optimally **decompress** left ventricle
 - Absence of MR
- **Avoid** leftward intraventricular **septal shift**
- **Avoid** LV **suction**

Understanding the Pump and Patient Interaction

PRELOAD

Low

Hypovolemia
Right Heart Failure
Tamponade

High

Hypervolemia

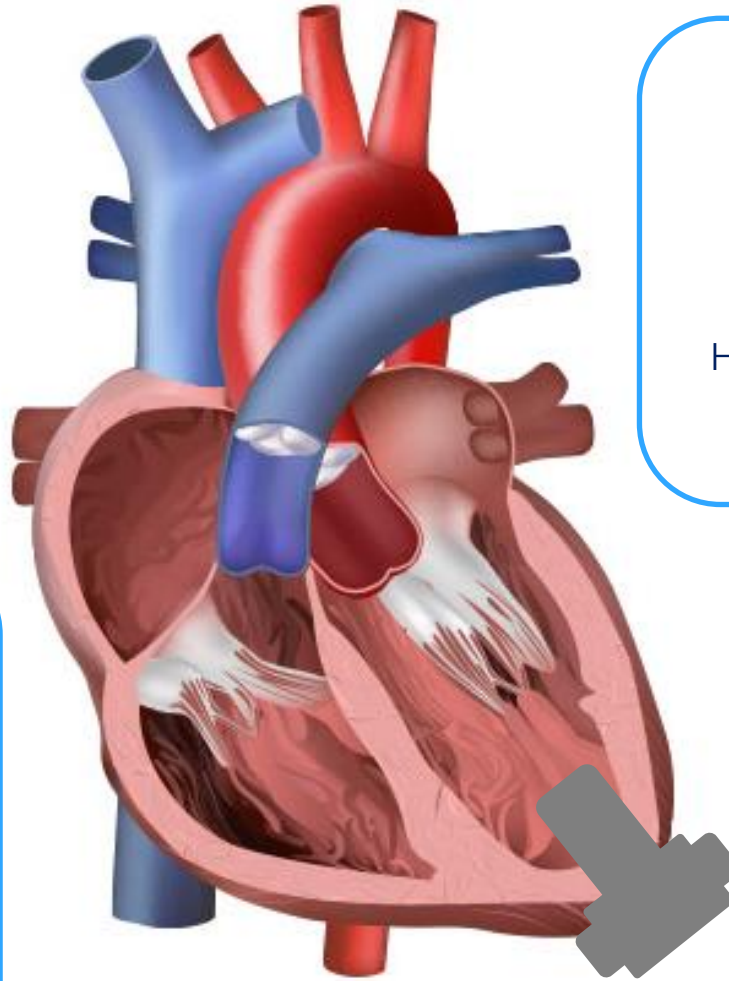
CONTRACTILITY

Low

Beta blockers
Worsening heart failure

High

Beta agonist
LV recovery



AFTERLOAD

Low

Low SVR – SIRS, Sepsis

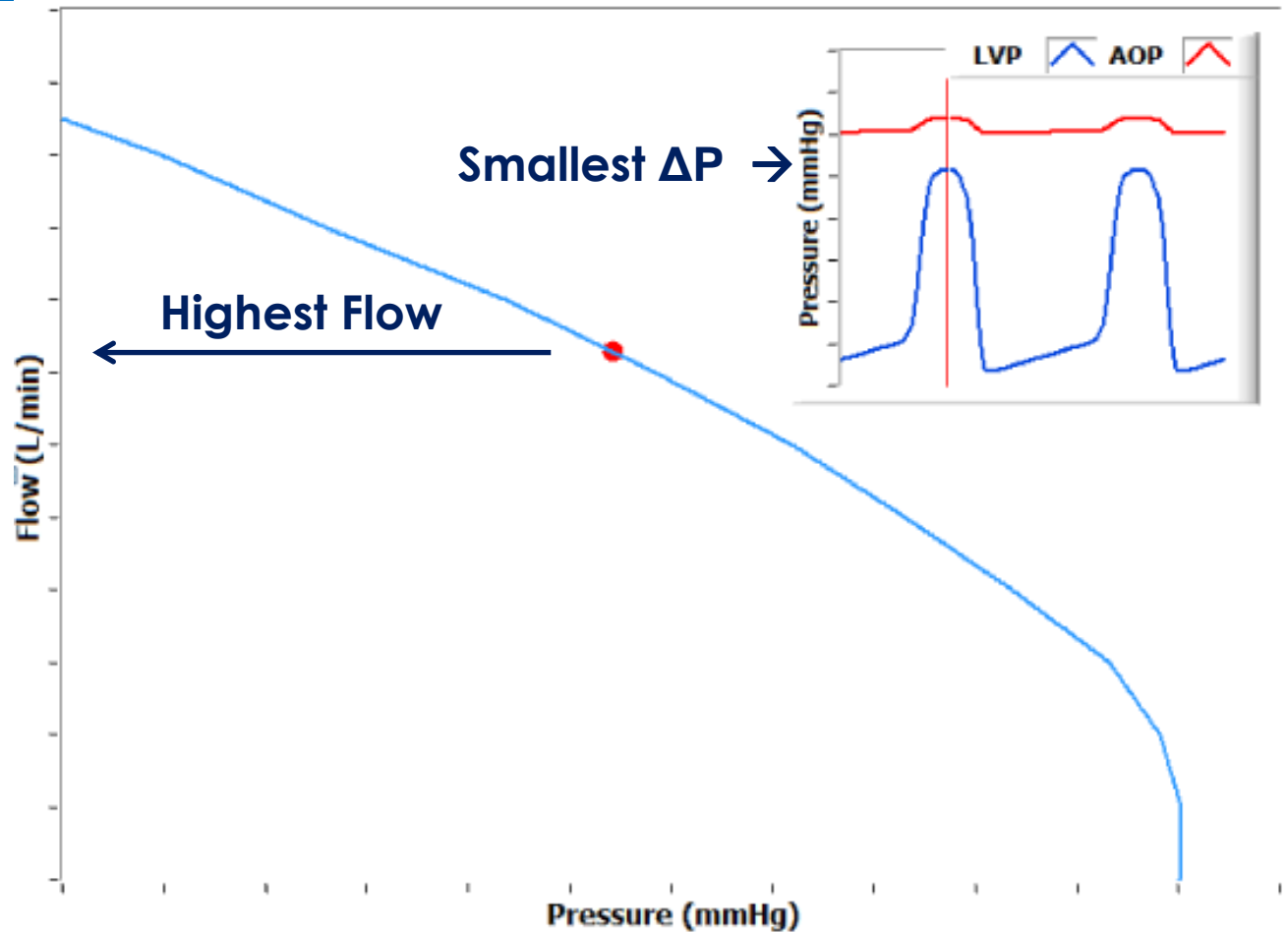
High

High SVR – heart failure
state, anesthesia

Device Set
Speed

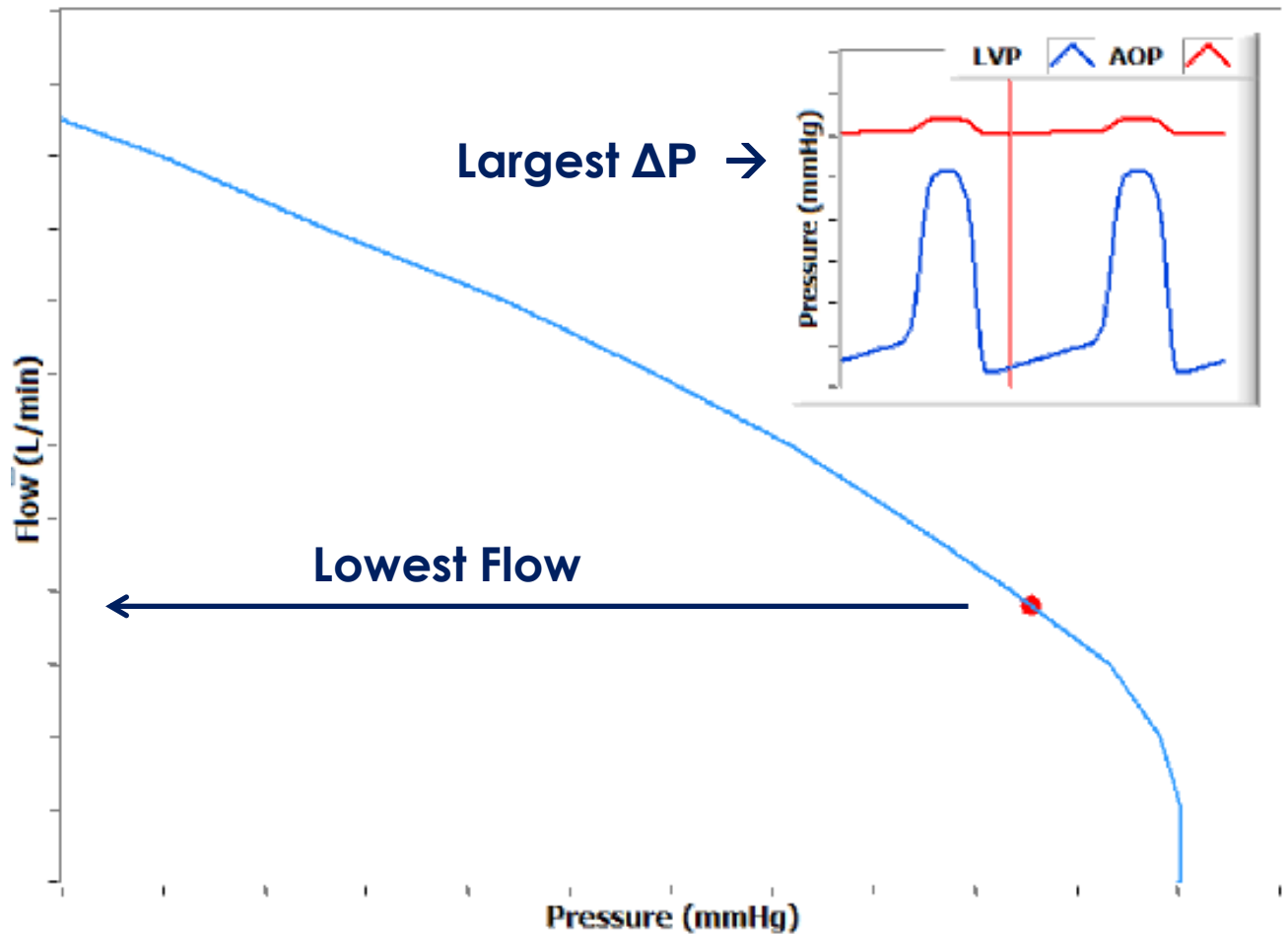
Peak Flow Occurs During Systole

Highest flow will occur at peak systole when ΔP is the smallest



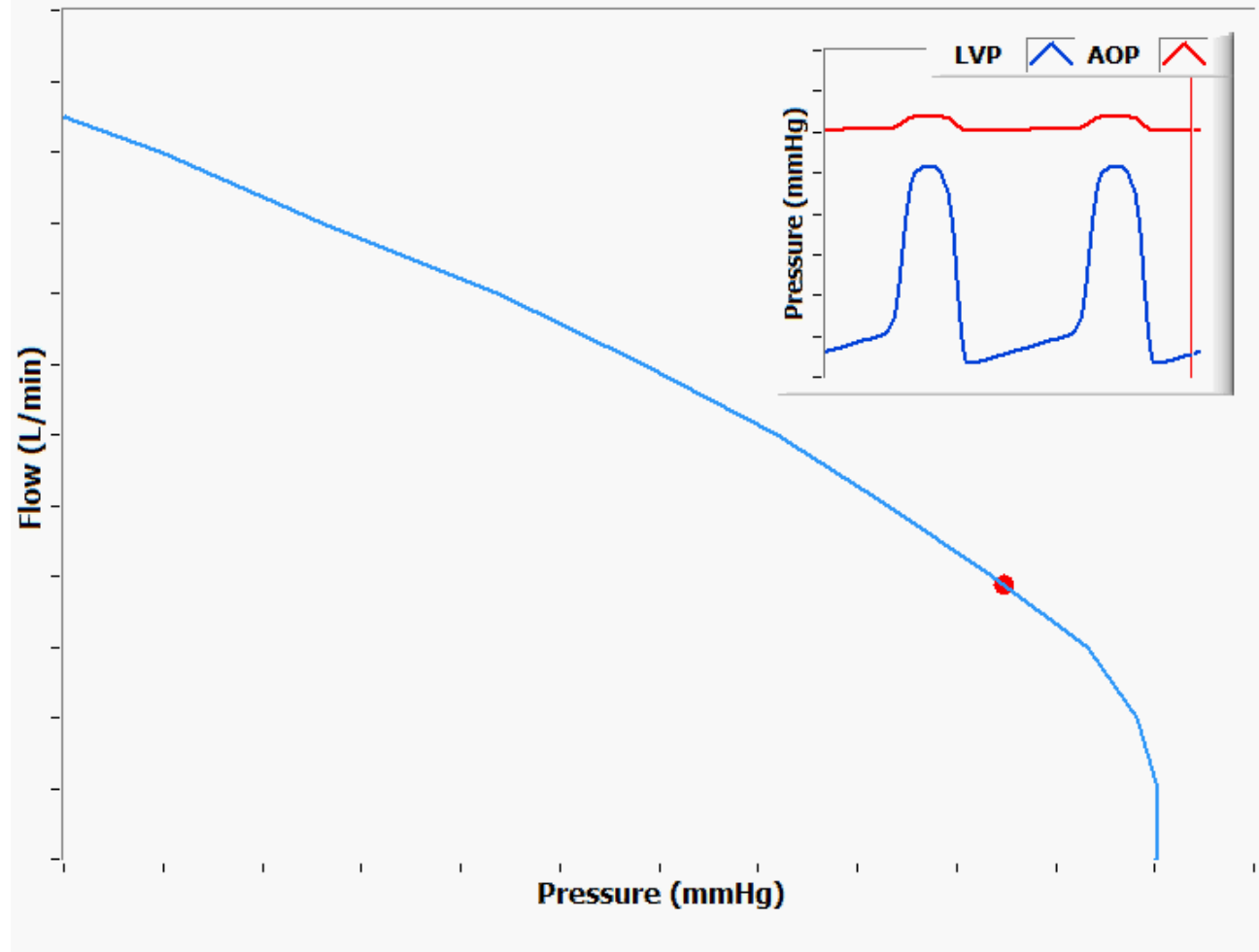
Lowest Flow Occurs During Diastole

Lowest flow will occur in diastole, when ΔP is the largest

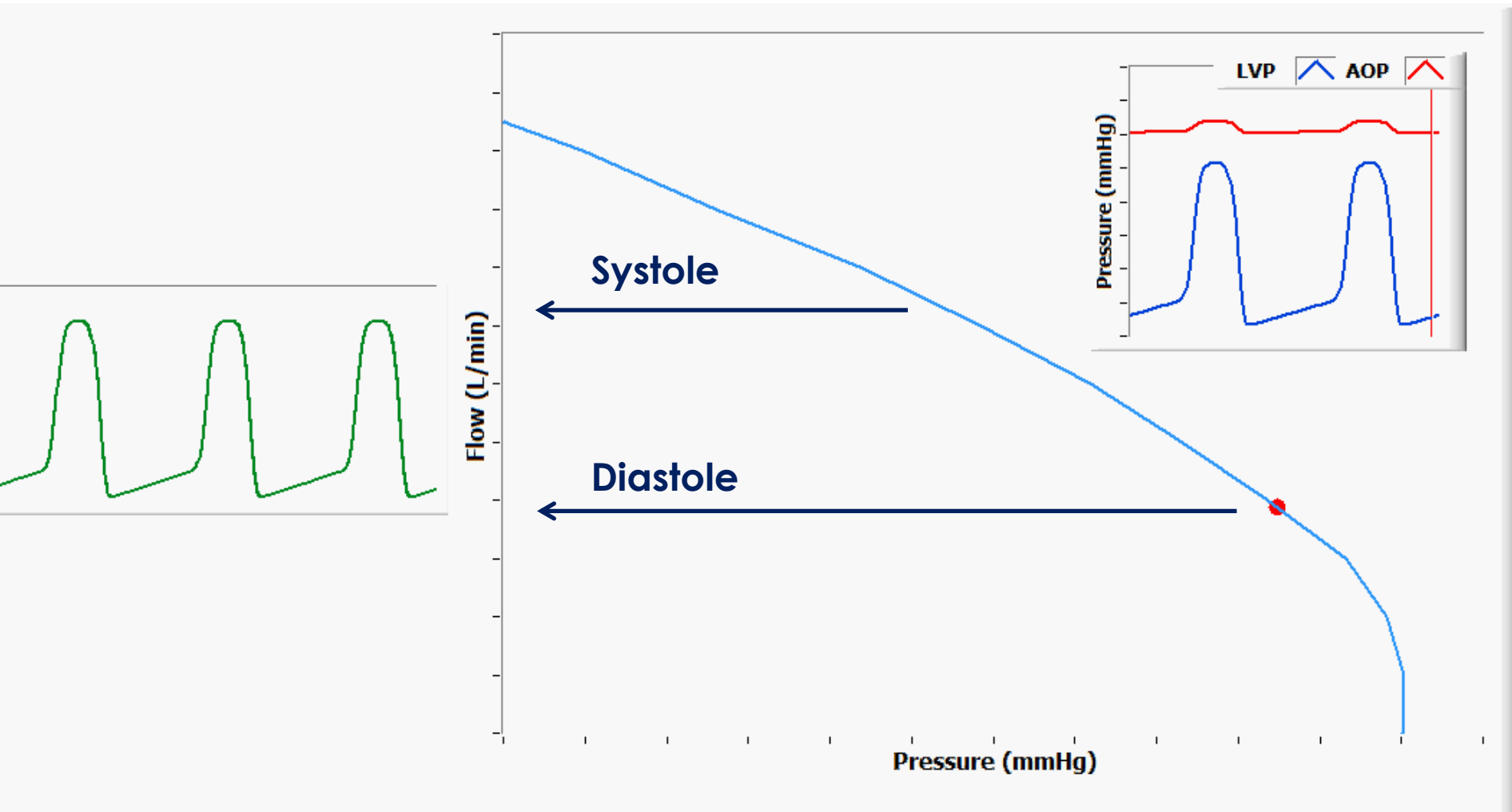


Flow-Pressure Curves Dictate Expected Flow

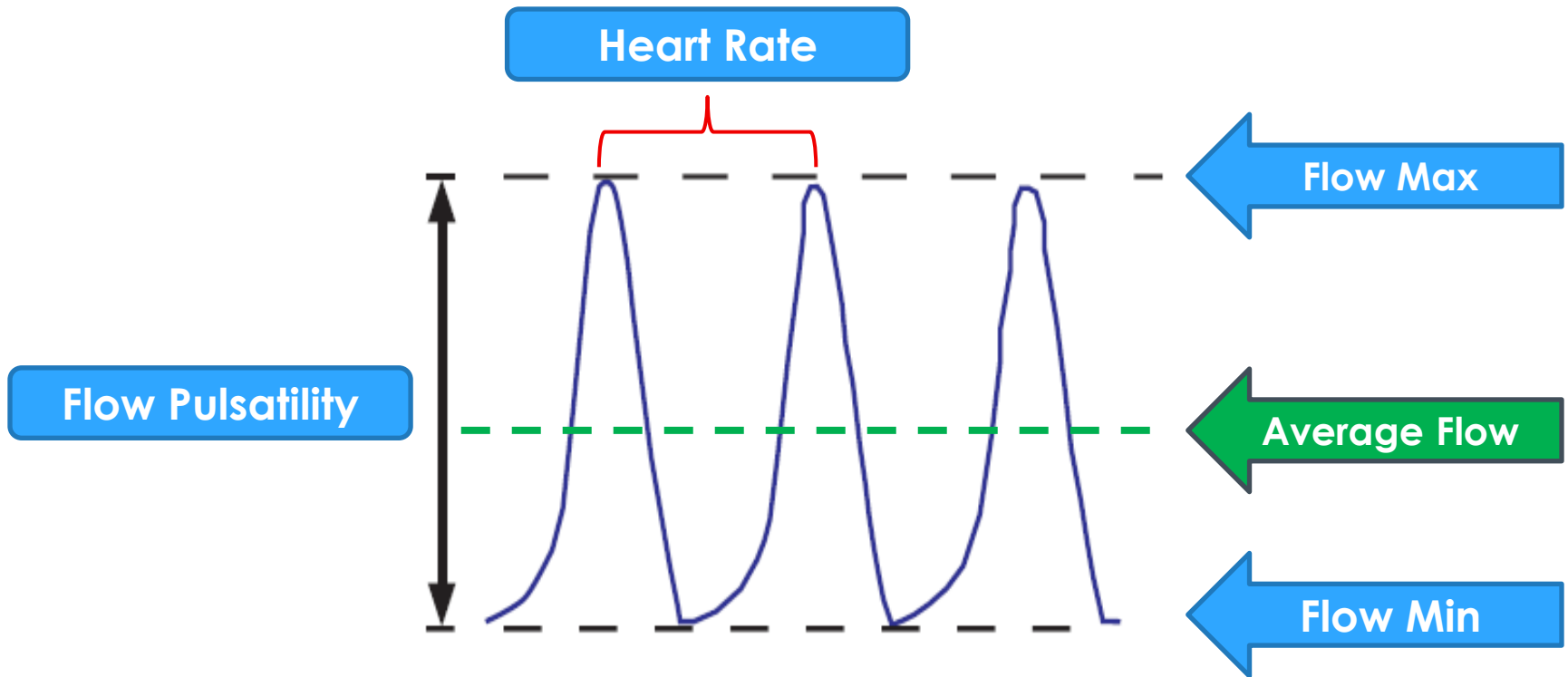
- Pump flow is a function of pressure gradient and RPM
- Pressure gradient (ΔP) is the pressure difference between the aortic and left ventricular (AoP – LVP)



Pulsatility Is A Result Of The Changes between Flow Peak and Trough



Pump Flow Waveform Characteristics



PATIENT ASSESSMENT AND INTERVENTION

Decreased Pump Flow Index

Differential Diagnosis	Hemodynamic Changes					Echo	HVAD	
	CVP	PAP	PAOP	MAP	SVO2		Power	Pulsatility
Hypovolemia	↓	↓	↓	↓	↓	Under-filled	↓	↓
Tamponade	↑	↓ Or No Change	↓	↓	↓	RV Compression	↓	↓
RHF	↑	↑ Or No Change	↓	↔	↓	Dilated RA/RV	↓	↓ Or No Change
Hypertension	↔	↑ Or No Change	↑	↑	↔	Dilated LA/LV, Ao opening	↓	↑
Occlusion	↑	↑	↑	↓	↓	Dilated LA/LV, Ao opening	↓ Less than expected	↓

Feldman, et.al., 2013 ISHLT MCS Guidelines. The Journal of Heart and Lung Transplantation, Vol 32, No 2, February 2013

Increased Pump Flow Index

Differential Diagnosis	Hemodynamic Changes					Echo	HVAD	
	CVP	PAP	PAOP	MAP	SVO2		Power	Pulsatility
Hypervolemia	↑	↑	↑	↑	↑	Normal	↑	↑
Vasodilation	↔	↔	↔	↓	↑	Normal, Ao opening	↑	↓
Aortic Insufficiency	↔	↑	↑	↓	↓	AI, MR, Inc LVEDD	↑	↓
Thrombus	↑	↑	↑	↓	↓	Dilated LA/LV, Ao Opening, MR	↑	↓

Feldman, et.al., 2013 ISHLT MCS Guidelines. The Journal of Heart and Lung Transplantation, Vol 32, No 2, February 2013

Recurring Heart Failure Symptoms

**Dysnea, Weight Gain, Fatigue,
Decreasing Functional Capacity**

Non Heart Failure Causes



COPD, General
debilitation,

Volume Status



Physical Exam
Laboratory Values
Echo Findings
RHC

HVAD Parameters



Flow, Power, Pulsatility,
Waveform Trough

Slaughter, et.al., Clinical Management Continuous-Flow LVADs. The Journal of Heart and Lung Transplantation, Vol 29, No 4S, April 2010

Interventions To Consider

Hypovolemia

- Give Volume
- Treat bleeding if cause

Tamponade

- Surgical takeback

RHF

- Decrease LVAD Speed
- Inotropes
- Temporary RVAD

Hypertension

- Adjust medications to decrease MAP

Occlusion

- Surgical Intervention

Hypervolemia

- Diuresis
- CRRT

Vasodilation

- Eval for cause (e.g. infection, medications)
- Support with fluid, pressors
- Reduce or hold vasodilators

Aortic Insufficiency

- Vasodilate
- Reduce Speed
- Surgical intervention

Thrombus

- Medical Management: increasing antiplt and anticoag meds
- Thrombolytics
- Pump Exchange

Summary

- Understanding the relationship between the patient and the pump is imperative
- Waveforms are a tool to provide insight into the patient's condition and help with patient management
- The pulsatility and shape of the waveform varies with clinical changes
- A systematic approach for the management and evaluation of patients can lead to improved patient management and effective interventions