

Hemodynamics

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- Hemodynamics are a measurement of the efficiency and efficacy of the cardiovascular system to provide oxygen to the tissues
- There are a number of values that can be obtained and understanding them can help manage your patient
- With the evolution of technology we can obtain these values a number of ways:
 - Arterial line with Vigileo monitoring
 - Central Venous Catheter
 - Swan Ganz Pulmonary Artery Catheter with Vigilance II monitor
- More information can be obtained about the Vigileo and Vigilance monitors at:
<http://www.edwards.com/education/pages/cceducationmap.aspx>



Hemodynamic Values

Parameter	Normal value	Causes of elevation	Causes of depression
Cardiac Output (CO)	4-8 Liters/min	Early sepsis, fever, thyroid storm, shock compensation (early), Inotropes, Mechanical assist devices	Heart failure, Shock (later), MI, valvular disease, arrhythmias, electrolyte imbalance
Cardiac Index (CI)	2.5-4 Liters/min/m ²	Same as above	Same as above
Systemic Vascular resistance (SVR)	900-1200 dynes/cm ²	Vasopressors, hypovolemia, late septic shock	Septic Shock, Neurogenic Shock, Early Sepsis, Vasodilators
Stroke Volume (SV)	60-80 ml	Increased circulating volume, inotropes	Impaired contractility, valve dysfunction, heart failure, MI
Ejection Fraction (EF)	55-70%	NA	MI, cardiomyopathy (dilated more than hypertrophic)
Pulmonary Artery Pressure (PAP)	20-30/5-15 mmHg	Left to right cardiac shunt, PA hypertension, COPD, PE, pulmonary edema, left ventricular failure, chronic hypoxia	NA
Pulmonary Artery Wedge/Occlusion Pressure (PAWP/PAOP), Left ventricular end diastolic pressure (LVEDP)	4-12 mmHg	Left ventricular failure, mitral valve pathology, MI, hypervolemia	Hypovolemia
Central Venous Pressure/Right Atrial Pressure (CVP/RAP)	2-6 mmHg	Decreased venous return, hypovolemia	Hypervolemia, right sided heart failure, MI
SvO₂ (Mixed Venous Oxygen Saturation)	60-80%	Increased CO, Decreased oxygen extraction at the tissues (left shift on oxyhemoglobin dissociation curve), Decreased oxygen demand at the tissues, increased SaO ₂	Decreased CO, decreased hemoglobin, decreased SaO ₂ , Increased oxygen consumption at the tissues (Not providing enough O ₂), Right shift of oxyhemoglobin dissociation curve

A Little More About SvO₂

Decreased SvO₂

Decrease in cardiac output	Hypovolemia or cardiac tamponade Shock Myocardial infarction Arrhythmias Increases in positive end-expiratory pressure
Decrease in oxygen saturation	Pulmonary edema Adult respiratory distress syndrome Decrease in inspired oxygen
Decrease in hemoglobin level	Anemia Hemorrhage Dysfunctional hemoglobin
Increase in oxygen consumption	Pain Anxiety or fear Agitation or restlessness Hyperthermia or burns Tachycardia Shivering Activity (positioning, suctioning)

Increased SvO₂

Decrease in oxygen consumption	Use of analgesics and anesthetics Neuromuscular blockade or use of paralytics Use of β -antagonists Hypothermia Hypothyroidism Sepsis (dysoxia, shunting) Cyanide poisoning Sleep or rest
Increase in oxygen saturation	Increase in fraction of inspired oxygen or hyperoxia Intracardiac shunt or arteriovenous fistula Severe mitral valve regurgitation Distal migration of a pulmonary artery catheter
Increase in cardiac output	Optimal preload Use of inotropic agents Use of mechanical-assist devices

Shock Differentiation with Hemodynamics

<i>Type of Shock</i>	<i>Cardiac Output/Index</i>	<i>SVR</i>	<i>PAWP</i>	<i>SvO₂</i>	<i>Treatments</i>
Cardiogenic	Low	Normal to high	Normal to high	Low	Revascularization, Inotropes, IABP
Distributive (Septic, Neurogenic)	High	Low	Low	High (early) Low (late)	IVF, Vasopressors
Hypovolemic	High	High	Low	Low	IVF, Blood