Cardiovascular Equations

Conduction Velocity:

$$\Theta^2 = \frac{A}{2RI}\frac{d^2V}{dt^2}$$

Θ = conduction velocity
A = cross-sectional area
R = resistance
I = capacitance
d^2V/dt^2 = second derivative of membrane voltage to time

Law of Laplace:

$$P = \frac{2HT}{r}$$

P = pressure
H = wall thickness
T = wall tension
r = chamber radius

Stroke Work:

$$SW = (P_{afterload})(SV) + \frac{1}{2} mv^2$$

$$SW = (MAP)(SV)$$

SW = stroke work
$P_{afterload}$ = afterload pressure
$mv^2/2$ = kinetic energy
SV = stroke volume
MAP = mean arterial pressure

Efficiency:

$$CE = \frac{SW}{QO_2}$$

CE = cardiac efficiency
SW = stroke work
QO_2 = oxygen consumption

Cardiac Output:

$$CO = HR\ (EDV - ESV)$$

$$CO = (HR)(SV)$$

CO = cardiac output
HR = heart rate
EDV = end diastolic volume
ESV = end systolic volume
SV = stroke volume

Ejection Fraction:

$$EF = (EDV - ESV)/EDV$$

EF = ejection fraction
ESV = end systolic volume
EDV = end diastolic volume

Flow through a tube:

$$VF = vA$$

VF = volumetric flow
v = velocity
A = cross-sectional area

Darcy's Law:

$$CO = \frac{MAP}{TPR}$$

CO = cardiac output
MAP = mean arterial pressure
TPR = total peripheral resistance

Poiseuille's Law:

$$R = \frac{8\eta l}{\pi r^4}$$

R = resistance **r** = tube radius
η = viscosity
l = tube length

Reynold's Number:

$$N_{Re} = \frac{vD\rho}{\eta}$$

$\mathbf{N_{Re}}$ = Reynold's number **ρ** = density
v = fluid velocity **η** = viscosity
D = tube diameter

Vascular Compliance:

$$C = V/P$$

C = compliance
V = volume
P = pressure

Organ Blood Flow:

$$Q_i = \frac{\Delta P}{R_i}$$

$\mathbf{Q_i}$ = volumetric flow to organ "i"
ΔP = perfusion pressure
$\mathbf{R_i}$ = resistance to organ "i"

Solute Exchange:

$$J_S = P_S S (C_C - C_I)$$

$\mathbf{J_S}$ = solute flux $\mathbf{C_C}$ = [solute] in capillary
$\mathbf{P_S}$ = permeability coefficient $\mathbf{C_I}$ = [solute] in interstitium
S = capillary surface area for exchange

Starling Equation:

$$J_F = L_P S [(P_C - P_T) - \sigma(\Pi_C - \Pi_T)]$$

$\mathbf{J_F}$ = transcapillary flux
$\mathbf{L_P}$ = hydraulic conductivity
σ = plasma protein reflection coefficient
S = capillary surface area for exchange
$\mathbf{P_C}$ = capillary hydrostatic pressure
$\mathbf{P_T}$ = tissue hydrostatic pressure
$\mathbf{\Pi_C}$ = capillary oncotic pressure
$\mathbf{\Pi_T}$ = tissue oncotic pressure