POTENTIALLY USEFUL EQUATIONS

Cardiovascular/Hemodynamic

Blood Pressure	**BP = CO x SVR** **P = F x R**
Cardiac Output (CO)	**HR x SV**
	Normal: 125-200 ml/kg/min, 3.5-5.5 L/m^2/min
Stroke Volume (SV)	**EDV-ESV**
	Normal: 1.5-2.5 ml/beat/kg, 40-60 ml/beat/m^2
Systemic Vascular Resistance (SVR)	$\frac{\text{MAP-CVP}}{\text{CO}}$
	Normal: 1600-2500 dynes * sec * cm^{-5}
Pulmonary Vasc. Resistance (PVR)	$\frac{\text{MPAP-PAOP}}{\text{CO}}$
	Normal: 125-250 dynes * sec * cm^{-5}
Ejection Fraction (EF)	$\frac{\text{EDV-ESV}}{\text{EDV}}$
	Normal: approx 70%

Fractional Shortening (FS)	$\frac{\text{EDD-ESD}}{\text{EDD}}$	
	Normal: 25-45% (dog), 30-55% (cat)	
Wall Stress	$\frac{P \times r}{2h}$	**P = pressure, r = radius** **h = wall thickness**
Poiseuille's Law	$Q = \Delta P/R$	
	$Q = \frac{\pi r^4 (P_1 - P_2)}{8\eta L}$	
	$R = \frac{8\eta L}{\pi r^4}$	**η = viscosity, L = length**
Continuity Equation	$Q = V \times A$	**V = velocity, A = x-sectional area**
Bernoulli Equation	$\Delta P = 4V^2$	
Reynolds Number	$\frac{2rv\rho}{\mu}$	**ρ = density, v = velocity, r = radius** **μ = viscosity**
	Normal: Values greater than 2000-2300 are associated with turbulent flow	
Starling Forces	$K_f(P_c-P_i) - \sigma(\pi_c-\pi_i)$	**K = filtration coefficient, σ = reflection coefficient (permeability)**
Compliance	$C = \Delta V/\Delta P$	

ECG Normals

	Dog	Cat
Heart rate	80-140	140-180
P wave width	0.04 sec	0.04 sec
P wave height	0.4 mV	0.2 mV
P-R interval	0.06-0.13 sec	0.05-0.09 sec
QRS width	0.06 sec	0.04 sec
QRS height	3.0 mV	0.9 mV
Q-T interval	0.15-0.25 sec	0.07-0.20 sec
ST segment	within 0.2 mV	none
T wave	pos, neg, biphas	pos, neg, bi.
MEA	40-100	0-160

Instantaneous Heart Rate

3000/x @ 50 mm/sec — **x = number of small boxes in R-R interval**

1500/x @ 25 mm/sec

Oxygen Tension Based Indicies

Art. Blood Oxygen Content (CaO2)

(1.36 x Hb x SaO2) + (0.003 x PaO2)

Normal: 20 ml O2/100 ml blood

Mixed Venous Oxygen Cont. (CvO2)

(1.36 x Hb x SvO2) + (0.003 x PvO2)

Normal: 15 ml O2/100 ml blood

Oxygen Delivery (DO2)

CO x CaO2

Normal: 20-35 ml/kg/min, 600-900 ml/m^2/min
Critical (D_{cO2}) 9-10 ml/kg/min

Oxygen Consumption (VO2)	**CO x (CaO2-CvO2)**
	CO x 13.6 x Hb x (SaO2-SvO2)
	Normal: 4-11 ml/kg/min, 150-250 ml/m^2/min
Oxygen Extraction Ratio (OER)	$$\frac{CaO2-CvO2}{CaO2} \quad \text{or} \quad \frac{SaO2-SvO2}{SaO2}$$
	Normal: 20-30%

Pulmonary

Tidal Volume (Vt)	**10-15 ml/kg**	
Minute Ventilation (VE)	**150-200 ml/kg/min**	
Alveolar Ventilation (VA)	**VA = VT – VD**	**VD = dead space**
Alveolar Ventilation	$$PACO2 = K \times \frac{VCO2}{VA}$$	**K = 0.863**
Bohr Equation (VD/VT)	$$VD/VT = \frac{PACO2-PECO2}{PACO2}$$	**PaCO2=PACO2, so can use in calcs**
Alveolar Gas Equation (PAO2)	**PIO2 – PaCO2/R**	
	PIO2 = Bar. Press – H2O vap. Press x FiO2	

Fick's Law (V = diffusion)

$$V = \frac{A \times D \times (P1-P2)}{T}$$

A = area, D = diffusion constant (solubility/MW), T = thickness

Pulmonary Shunt (Qs/Qt)

$$\frac{CcO2-CaO2}{CcO2-CvO2} \quad \text{or} \quad \frac{1-SaO2}{1-SvO2}$$

Normal: Less than 10%

Pulmonary Capillary O2 Content

$$(1.36 \times Hb \times SAO2) + (0.003 \times PAO2)$$

Fluids/Electrolytes

Blood Transfusion

$$Wt\ (kg) \times \frac{\text{Desired PCV} - \text{Recipient PCV}}{\text{Donor PCV}} \times 90 \text{ or } 60$$

Also, 2 ml/kg whole blood or 1 ml/kg PRBC will increase PCV 1%

Blood in Abdomen

$$\frac{\text{PCV of lavage} \times \text{volume of lavage fluid}}{\text{PCV (before fluids)} - \text{PCV of lavage}}$$

Also, 40 ml/kg to see distension

Free Water Deficit

$$Wt\ (kg)\ \text{present} \times \left(\frac{\text{Na present}}{\text{Na prev.}} - 1\right)$$

Bicarbonate Deficit

$$Wt\ (kg) \times (24-HCO3) \times 0.3$$

Corrected Chloride

$$\text{Cl measured} \times \frac{\text{Na normal}}{\text{Na meas}}$$

Corrected Calcium	**Calcium – albumin + 3.5**	
Calculated Osmolality	$2(Na+K) + \frac{BUN}{2.8} + \frac{BG}{18}$ **Normal: 290-310 (dogs), 290-330 (cats)**	
Anion Gap	**(Na+K) – (Cl+HCO3)** **Normal: 12-20**	
Corrected Sodium (BG)	$\text{Measured Sodium} + 1.6 \times \frac{(BG-100)}{100}$	
Single Nephron GFR	$Kf \times (P_{GC} - P_T - \pi_{GC})$	**Kf dependent on surface area, and permeability of glomerulus**
GFR (clearance)	$GFR = U_x V / P_x$	U_x **= urine conc. in mg/ml, V = urine flow rate in ml/min,** P_x **= plasma conc. in mg/ml**

Random Named Things

Haldane Effect	**Hemoglobin has a greater buffering capacity in the deoxygenated state**
Bohr Effect	**Hemoglobin has decreased affinity for CO2 when O2 is bound, enhancement of CO2 dissociation and elimination in the lungs, also converse is true, and increased** H^+ **and CO2 decrease affinity for O2 (shifts curve to the right)**