

# Loan Lifelife Calculator

$$\text{cost} = \left( \frac{\frac{\text{rate}}{12}}{1 - (1 + \frac{\text{rate}}{12})^{-\text{duration}}} \right) \cdot \text{price} \cdot \text{duration}$$

[Ventilator Pocket Guide](#)

## Foundational Equations

<b>Ohm's Law</b>	$\Delta P = FR = P_{aw} - P_{alv} = P_{pl} - PEEP_{total}$
<b>Equation of Motion</b>	$P_{aw} = FR + \frac{V_t}{C} + PEEP_{total}$
<b>Compliance</b>	$C = \frac{\Delta V}{\Delta P}$
<b>Natural Decay Equation</b>	$V_i(t) = \frac{V_o}{RC} \left( e^{-\frac{t}{RC}} - e^{-\frac{t}{\tau}} \right)$
<b>Calculating <math>\tau</math>, General Case</b>	$\tau = \frac{V_t}{F} \left( \frac{PIP - P_{plt}}{P_{plt} - PEEP_{total}} \right)$
<b>Alveolar Gas Equation</b>	$P_{AO_2} = F_{iO_2}(P_{atm} - P_{H_2O}) - \frac{P_{aCO_2}}{RQ}$ , where $RQ = 0.80$
<b>Mech Power, VC</b>	$MP_{VC} = 0.098 \cdot RR \cdot V_t \left[ PIP - \frac{1}{2}(P_{plat} - PEEP) \right]$
<b>Mech Power, PC</b>	$MP_{VC} = 0.098 \cdot RR \cdot V_t \left[ PEEP + \Delta P_{insp} \left( 1 - e^{-\frac{T_{insp}}{RC}} \right) \right]$

## Respiratory Equations

### Mechanical Power

#### Volume Control

$$MP_{VC} = 0.098 \cdot RR \cdot V_t \left[ PIP - \frac{1}{2}(P_{plat} - PEEP) \right] \approx \frac{MV(P_{peak} + PEEP + \frac{Q_{insp}}{6})}{20}$$

#### Pressure Control

$$MP_{VC} = 0.098 \cdot RR \cdot V_t \left[ PEEP + \Delta P_{insp} \left( 1 - \exp\left(-\frac{T_{insp}}{RC}\right) \right) \right]$$

$$MP_{VC} = 0.098 \cdot RR \cdot V_t \left[ PEEP + \Delta P_{insp} \left( 1 - e^{-\frac{T_{insp}}{RC}} \right) \right] \approx 0.098 \cdot RR \cdot V_t (PEEP + \Delta P_{insp})$$

- [Vent Waveforms](#)

### Alveolar Gas Equation

$$P_{AO_2} = F_{iO_2}(P_{atm} - P_{H_2O}) - \frac{P_{aCO_2}}{RQ}$$

substituting back in to  $RQ$  equation:  $RQ = \frac{P_{ACO_2}}{\frac{V_{AP_{ACO_2}}}{kVO_2}} =$

$$\frac{V_{O_2}}{V_a}k$$

$$V_T = V_A + V_D, \text{ where } V_A = 350 \text{ and } V_D = 150$$

### Shunt Equation (Berggren Equation)

$$\frac{Q_s}{Q_t} = \frac{C_{C_{O_2}} - C_{a_{O_2}}}{C_{C_{O_2}} - C_{v_{O_2}}}$$

where:

- $Q_s$  = pulmonary physiology shunt  $(\frac{mL}{min})$
- $Q_t$  = cardiac output  $(\frac{mL}{min})$
- $C_{C_{O_2}}$  = end-pulmonary-capillary oxygen content
- $C_{a_{O_2}}$  = arterial oxygen content
- $C_{v_{O_2}}$  = mixed venous oxygen content

So, you will need an ABG and a true mixed VBG (art line + SGC).

### Derivation

### Dead Space Fraction

$$\frac{V_D}{V_T} = \frac{P_{ACO_2} - P_{ECO_2}}{P_{ACO_2}}$$

Formal measurement of  $P_{ECO_2}$  requires volumetric capnography, which requires a capable ventilator or a dedicated measurement device.

Thankfull,  $P_{ECO_2} \approx ETCO_2$ , so an approximation would  $\frac{V_D}{V_T} = \frac{P_{ACO_2} - ETCO_2}{P_{ACO_2}}$

### Alveolar ventilation

$$P_{AO_2} = F_{iO_2}(P_{atm} - P_{H_2O}) - \frac{P_{AO_2}}{RQ}$$

$$\dot{V}_A = k \frac{\dot{V}CO_2}{P_{ACO_2}} \implies \dot{V}CO_2 = \frac{\dot{V}_A P_{ACO_2}}{k}$$

To convert  $F_{ACO_2}$  into  $P_{ACO_2}$ , we have  $F_{ACO_2}(P_{atm} - P_{H_2O}) = P_{ACO_2}$  Similarly, using  $F_{ECO_2}$ , we can show  $P_{ECO_2} = F_{ECO_2}(P_{atm} - P_{H_2O})$

$$Volume_{expiredCO_2} = Volume_{producedAlvCO_2}$$

$$V_{TF_{ECO_2}} = V_{AF_{ACO_2}}$$

$$V_{TF_{ECO_2}} = (V_T - V_D)F_{ACO_2}, \text{ and we can convert } F_{ACO_2} \text{ into } P_{ACO_2}$$

## PULM

### Equation of Motion

$$P_{\text{delivered}} = P_{\text{resistive}} + P_{\text{elastic}}$$

$$P_{\text{aw}} = \dot{V}R + \frac{V_t}{C} + \text{PEEP}_{\text{total}} + P_{\text{musc}}$$

### CPET Testing

#### Heart rate reserve

$$\text{HRR} = \text{HR}_{\text{achieved}}^{\text{max}} - \text{HR}_{\text{predicted}}^{\text{peak}},$$

$$\text{where } \text{HR}_{\text{predicted}}^{\text{peak}} = 220 - \text{age}$$

#### Slope of work efficiency

$$m(\text{work}_e) = \frac{\Delta \text{VO}_2}{\Delta \text{WR}}$$

#### Slope of heart rate rise

$$\frac{\Delta \text{HR}}{\Delta \text{VO}_2}$$

## CARDS

$$\text{TPG} = \text{mPAP} - \text{PCWP}$$

$$\text{SVR} = \frac{\text{MAP} - \text{CVP}}{\text{CO}} \cdot 80$$

$$\text{PVR} = \frac{\text{mPAP} - \text{PCWP}}{\text{CO}} \cdot 80$$

$$\text{CO} = \text{LVOT}_{\text{area}} \cdot \text{LVOT}_{\text{VTI}} \cdot \text{HR}$$

### Swan-Ganz Equations

$$\text{CO} = \frac{\text{VO}_2}{C_a - C_v}, \text{ where } C_v = \text{ScvO}_2 \text{ (mixed venous oxygen content)}$$

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