

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>	$V_i(t) = \frac{V_o}{e^{\frac{t}{RC}}} = \frac{V_o}{e^{\frac{t}{\tau}}}$
<b>Calculating <math>\tau</math>, General Case</b>	$\tau = \frac{V_t}{F} \cdot \left( \frac{PIP - P_{plt}}{P_{plt} - PEEP_{total}} \right)$
<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>	$\{MP\}_{VC} = 0.098 \cdot RR \cdot V_t [PIP - \frac{1}{2}(P_{plat} - PEEP)]$
<b>Mech Power, PC</b>	$\{MP\}_{VC} = 0.098 \cdot RR \cdot V_t [PEEP + \Delta P_{insp} (1 - e^{-\frac{T_{insp}}{RC}})]$

### Respiratory Equations

#### Mechanical Power

##### Volume Control

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

##### Pressure Control

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

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

- [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:  $RQ = \frac{P_{ACO_2}}{\frac{V_{AP_{ACO_2}}}{kV_{O_2}}} = \frac{V_{O_2}}{V_a} k$

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

## Shunt Equation (Berggren Equation)

$$\frac{Q_s}{Q_t}$$

## 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  $P_{ECO_2} = F_{ECO_2}(P_{atm} - P_{H_2O})$

$$Volume_{\text{expiredCO}_2} = Volume_{\text{producedAlvCO}_2}$$

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

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

## PULM

### Equation of Motion

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

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

## CARDS

$$TPG = mPAP - PCWP$$

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

$$CO = LVOT_{\text{area}} \cdot LVOT_{\text{VTI}} \cdot HR$$

## Swan-Ganz Equations

$CO = \frac{VO_{2}}{C_a - C_v}$ , where  $C_v = ScvO_2$  (mixed venous oxygen content)

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