

Ventilator Pocket Guide

Foundational Equations

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| Ohm's Law | $\Delta P = FR = P_{aw} - P_{alv} = P_{pl} - PEEP_{total}$ |
| Equation of Motion | $P_{aw} = FR + \frac{V_t}{C} + PEEP_{total}$ |
| Compliance | $C = \frac{\Delta V}{\Delta P}$ |
| Natural Decay Equation | $V_i(t) = \frac{V_o}{e^{\frac{t}{RC}}} = \frac{V_o}{e^{\frac{t}{\tau}}}$ |
| Calculating τ, General Case | $\tau = \frac{V_t F}{\ln(\frac{P_{plat} - P_{PEEP}}{P_{plat} - P_{PEEP}})}$ |
| Alveolar Gas Equation | $P_{AO_2} = F_{IO_2}(P_{atm} - P_{H_2O}) - \frac{P_{aCO_2}}{RQ}$, where $RQ = 0.80$ |
| Mech Power, VC | $MP_{VC} = 0.098 \cdot RR \cdot V_t [PIP - \frac{1}{2}(P_{plat} - P_{PEEP})]$ |
| Mech Power, PC | $MP_{PC} = 0.098 \cdot RR \cdot V_t [PEEP + \Delta P_{insp} (1 - e^{-\frac{T_{insp}}{RC}})]$ |

Respiratory Equations

Mechanical Power

Volume Control

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

Pressure Control

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

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

- 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: $RQ = \frac{P_{aCO_2}}{\frac{V_{AP_ACO_2}}{kVO_2}} = \frac{VO_2}{V_a}$

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

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 appromiation would $\frac{V_D}{V_T} = \frac{P_{ACO_2} - ETCO_2}{P_{ACO_2}}$

Alveolar ventilation

$$\begin{aligned} P_AO_2 &= F_iO_2(P_{atm} - P_{H_2O}) - \frac{P_{AO2}}{RQ} \\ \dot{V}_A &= k \frac{\dot{V}CO_2}{P_{ACO_2}} \text{ implies } \dot{V}CO_2 = \frac{\dot{V}AP_{ACO_2}}{k} \end{aligned}$$

To convert F_{ACO_2} into P_{ACO_2} , we have $F_{ACO_2}(P_{atm}) - PH_2O = P_{ACO_2}$ Similarly, using F_{ECO_2} , we can show $P_{ECO_2} = F_{ECO_2}(P_{atm} - P_{H_2O})$

$$Volume_{expiredCO2} = Volume_{producedAlvCO2}$$

$$V_{TF_ECO_2} = V_{AF_ACO_2}$$

$$V_{TF_ECO_2} = (V_T - V_D)F_{ACO_2}, \text{ and we can convert } F_{ACO_2} \text{ into } P_{ACO_2}$$

PULM

Equation of Motion

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

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

CARDS

$$TPG = mPAP - PCWP$$

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

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

Swan-Ganz Equations

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

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