LET'S TALK ABOUT APRV

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CONFLICT OF INTEREST

Nothing to disclose

OBJECTIVES

- Define APRV and TCAV
- Explain the four major parameters
- Recommend appropriate initial settings for APRV both traditional and using the TCAV method
- Make adjustments based on arterial blood gas results

DEFINITIONS

APRV= Airway Pressure Release Ventilation

TCAV= Time Controlled Adaptive Ventilation- a method of adjusting the set parameters biased on the patient's condition

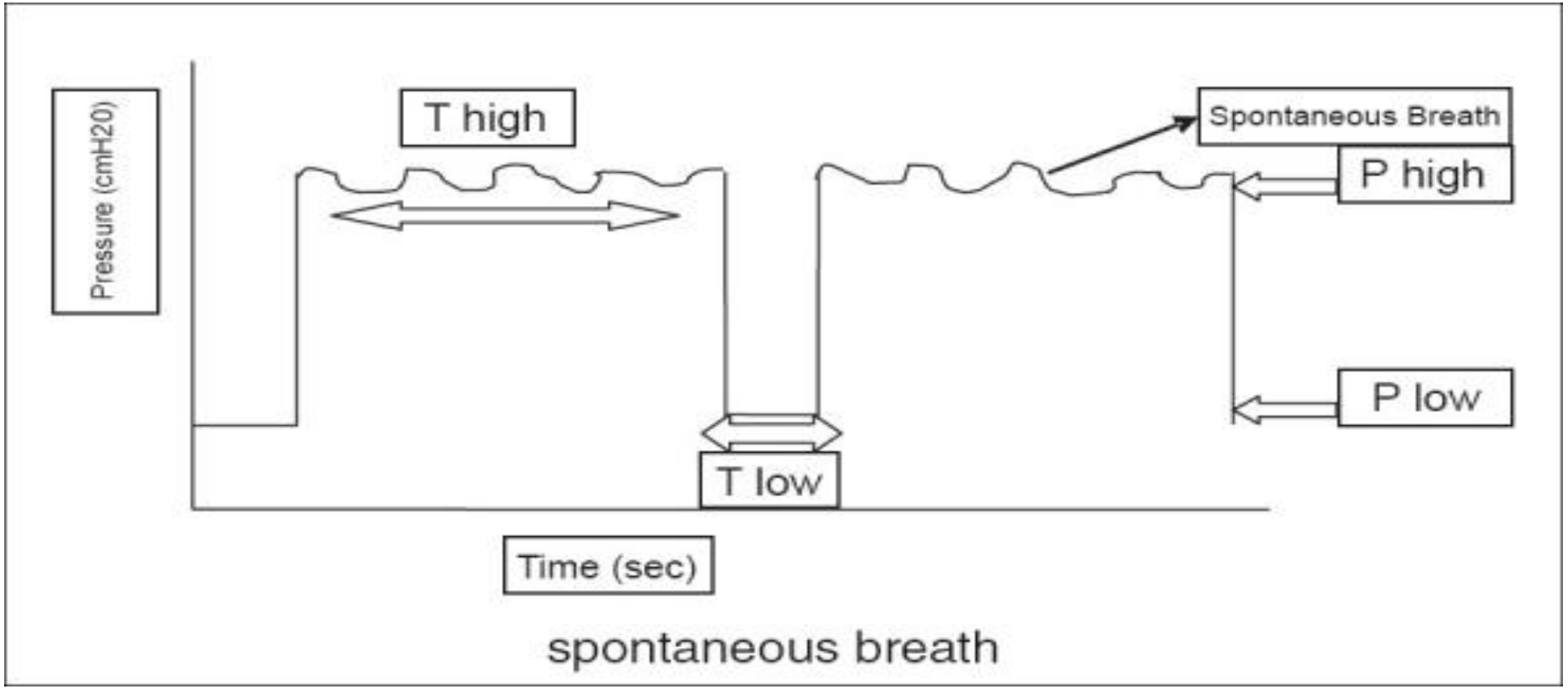
The four major parameters of APRV

P_{high}

T_{high}

T_{low}

P_{low}



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Traditional APRV initial settings

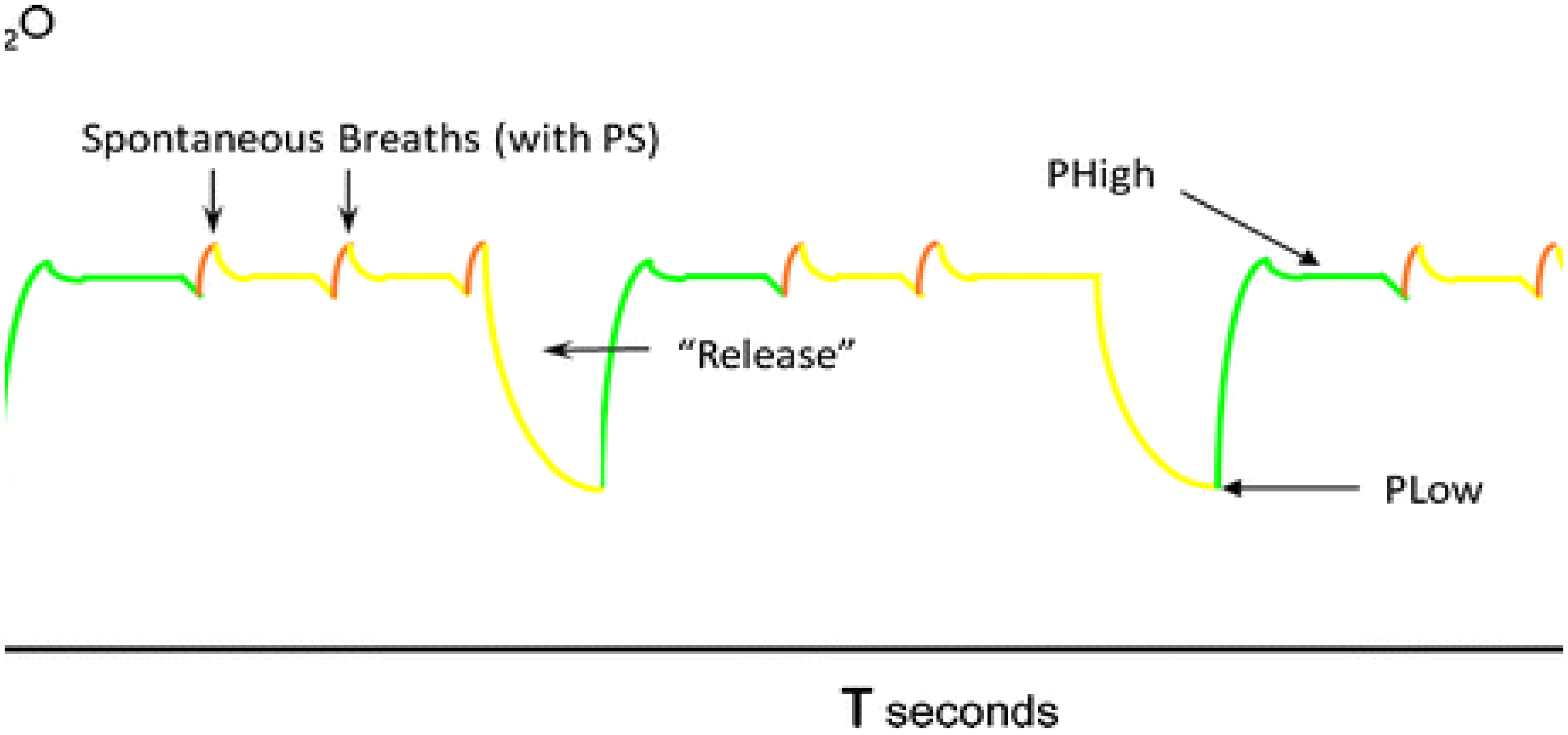
P_{high}: 20-25 cmH_2O (30 cmH_2O max)

T_{high}: 4-5 seconds

P_{low}: 0 cmH_2O

T_{low}: 0.5 seconds but prefer pt. specific lasting 50-75% of the expiratory flow peak

FiO_2: 100% and reduce to <60% as tolerated



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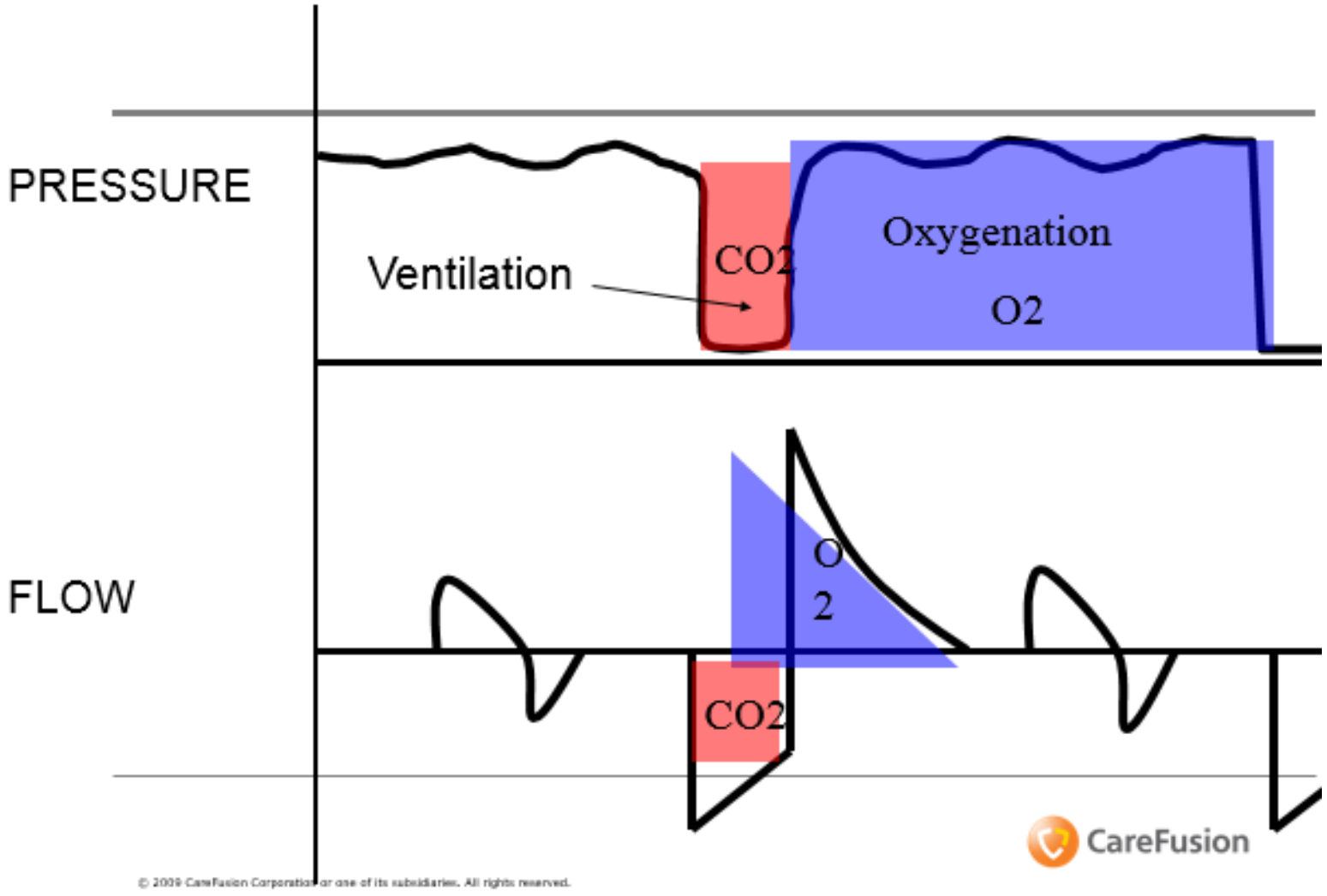
PRESSURE
Ventilation
CO2
Oxygenation
O2
FLOW
O
2
CO2
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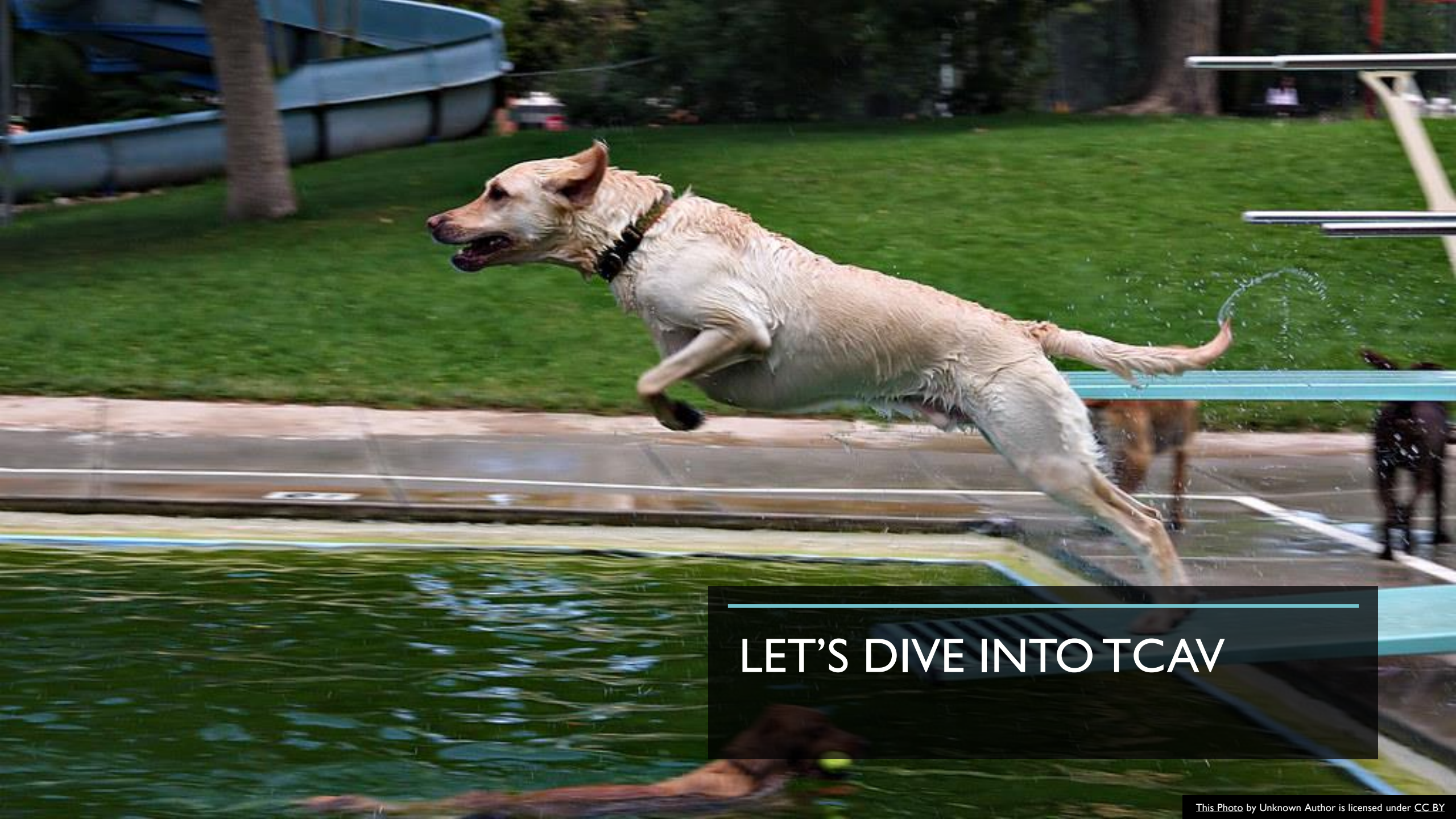
GOALS

- pH $\geq$ 7.25 $\leq$ 7.45
- $PaCO_2$ < 60 mmHg
- PaO_2 55-80 mmHg
- SaO_2 > 88%
- FiO_2 <50%
- Pplat < 30 cmH_2O



LET'S DIVE INTO TCAV

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Time Controlled Adaptive Ventilation- a protocol/method to set your parameters based on the patient's current status.

- TCAV This Time Controlled Adaptive Ventilation (TCAV) Method has been utilized by Nader M. Habashi, MD, FACP, FCCP of the R Adams Shock Trauma Center in Baltimore, Maryland.

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SPECIFIC TCAV SETTINGS

- P_{HIGH} set at plateau pressure or peak pressure on prior mode
- T_{HIGH} set based on the patient's respiratory rate. A faster respiratory rate will result in a shorter T_{HIGH} and a slower rate will result in a longer T_{HIGH}
- The release phase (T_{low}) is calculated by expiratory flow terminating (E_{ft}) at 75% of the expiratory flow peak (E_{FP})
- P_{low} will always be set at 0

SPECIFIC TCAV T_{HIGH} & T_{LOW} SETTINGS

T_{High} (seconds)**	Set to match rate on mode transitioning from using the formula: (60/current rate) – T_{Low} (i.e. rate 26; (60/26) = 2.3 If T Low is 0.5, then T High would be set to 1.8 seconds
T_{Low} (seconds)*** set to E_{FT}/E_{FP} of 75%. **NOTE**: These ranges are a ***starting point*** and may require adjustment to achieve E_{FT}/E_{FP} of 75%.	Adults - 0.3-0.6 Pediatrics – 0.2-0.5 Neonates – 0.2-0.3

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SETTING EXPLANATION ACCORDING TO THE TCAV NETWORK

P_{high} is set to maintain lung inflation along the steep portion of the pressure-volume curve (between functional residual capacity(FRC) and total lung capacity (TLC). Important to remember recruitment may happen quickly-monitor recruitment by the curvature of the diaphragm.

P_{low}- Set at 0 due to the release set to terminate at 75% of E_{FP}

T_{high}- Controls the bulk rate (convective) and alveolar (diffusive) ventilation. Also controls end-inspiratory lung volume and promotes alveolar stability to increase and maintain lung recruitment.

T_{low}-is the duration of the release phase and controls the amount of airway pressure (P_{high}) and lung volume to be released. T_{low} also controls the amount of retained end-expiratory lung volume and pressure.

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Examples of the benefit of E_{FT}/E_{FP} at 75%

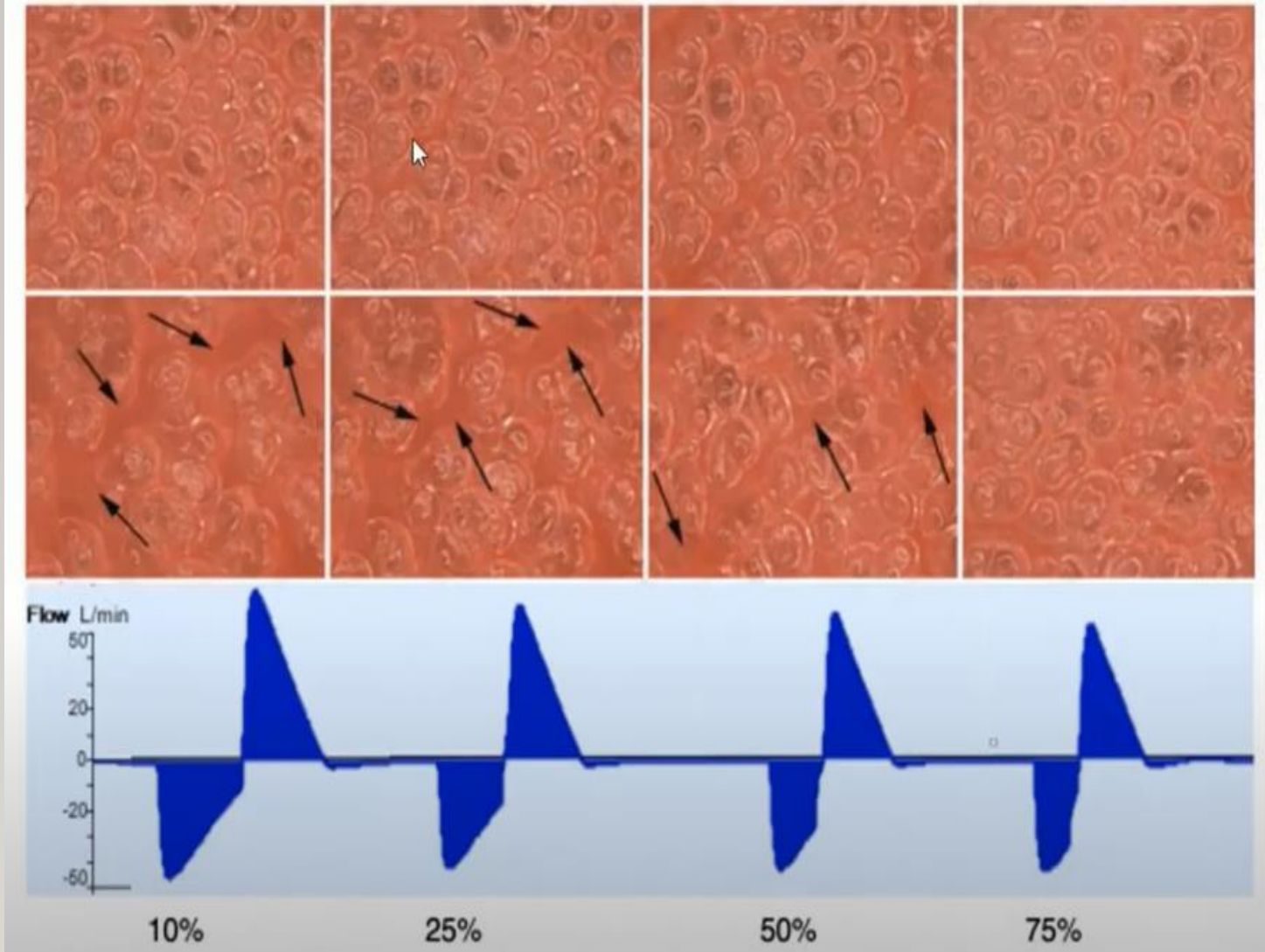

Figure 6 - Alveolar Microscopy at 4 different T_{Low} settings with E_{FT}/E_{FP} [left to right] at 10%, 25%, 50% and 75%. As the

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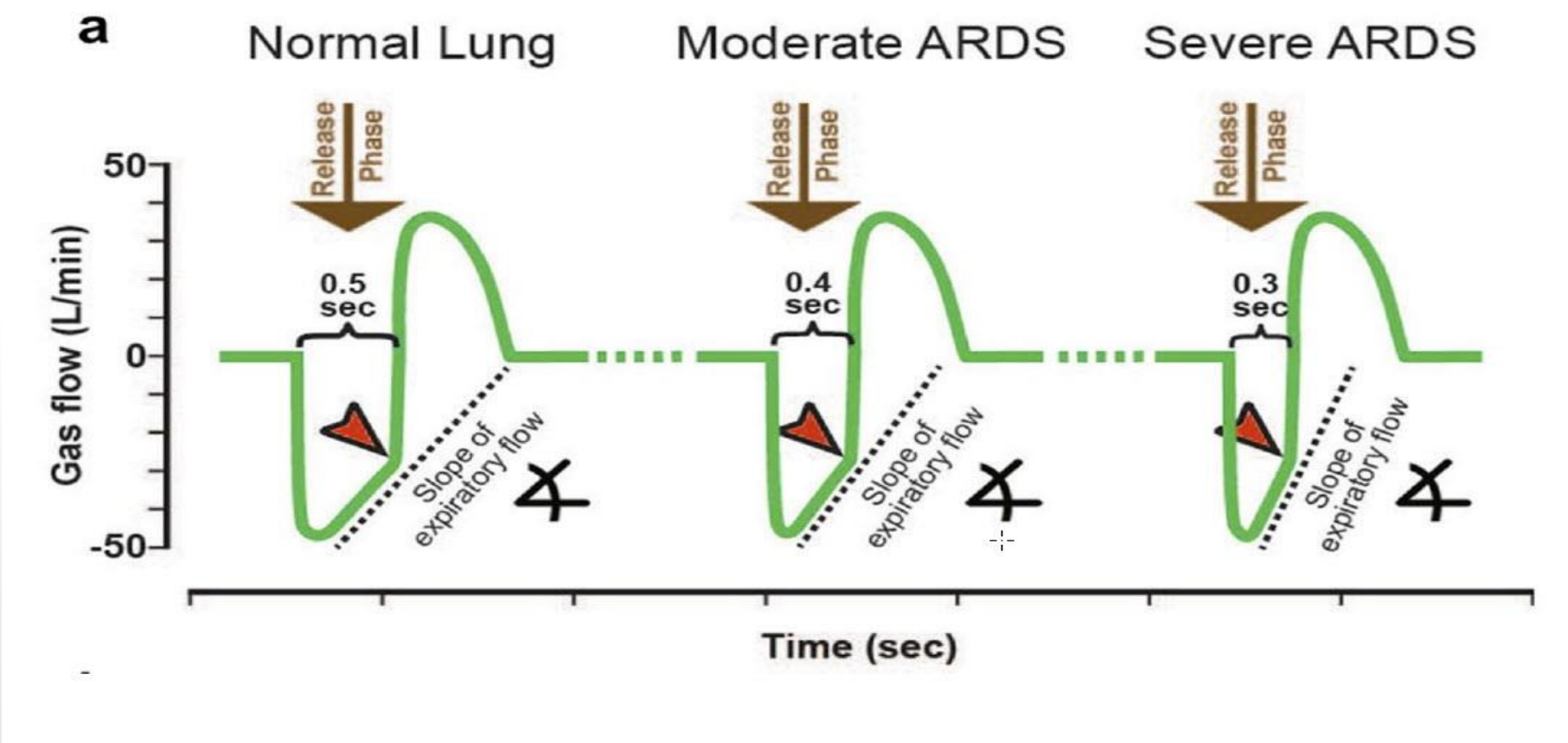
ADJUSTING T_{LOW} TO 75%

ADJUSTING T_{LOW} TO 75%



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APRV USING TCAV METHOD AS INITIAL MODE

Table 2 - Initial APRV Settings using the TCAV method as initial mode.

These settings are ideal when using TCAV as the initial mode in patients with post-operative atelectasis or airway protection for normal lungs and should not be used as a **rescue strategy** (See Rescue APRV-TCAV Guidelines).

Initial Settings – adjustment to settings are based on analysis of MVe, slope angle and blood gases	**Normal**	**Mild**	**Moderate**
P_{High} (cmH_2O)* Set based on degree of acute lung pathology (i.e. atelectasis, edema, etc.)	15-19	20-24	24-29*
P_{Low} (cmH_2O)	0	0	0
T_{High} (seconds) ** Consider rate required based on respiratory/metabolic acidosis. NOTE: Use these ranges as a *starting point* and adjust based on blood gas.	2-4	2-3	1-3
T_{Low} (seconds)** set to E_{FT}/E_{FP} of 75%. **NOTE**: These ranges are a ***starting point*** and may require adjustment to achieve E_{FT}/E_{FP} of 75%.	0.4-0.6	0.3-0.5	0.2-0.4

*A P_{High} greater than 29 cmH_2O may be required depending on body habitus and with increased chest wall elastance

** When transitioning to Rescue TCAV, Vt typically decreases to <6mL/kg resulting in a lower minute ventilation (MVe). In this case increase the (MVe) by (decreased T_{High} i.e. (rate) to achieve or exceed previous MVe. **DO NOT** increase MVe by increasing T_{Low} unless E_{FT}/E_{PF} is >75 as this will decrease alveolar stability. If Vt is <3mL/kg consider increasing P_{High} or a combination of increased P_{High} and decreased T_{High}. As the lung recruits [compliance improves], MVe requirements decrease allowing the T_{High} to be increased.

These are ***ranges for initial T_{Low} settings.

The T_{Low} setting that achieves E_{FT}/E_{FP} of 75% may be higher or lower than these initial suggested ranges.

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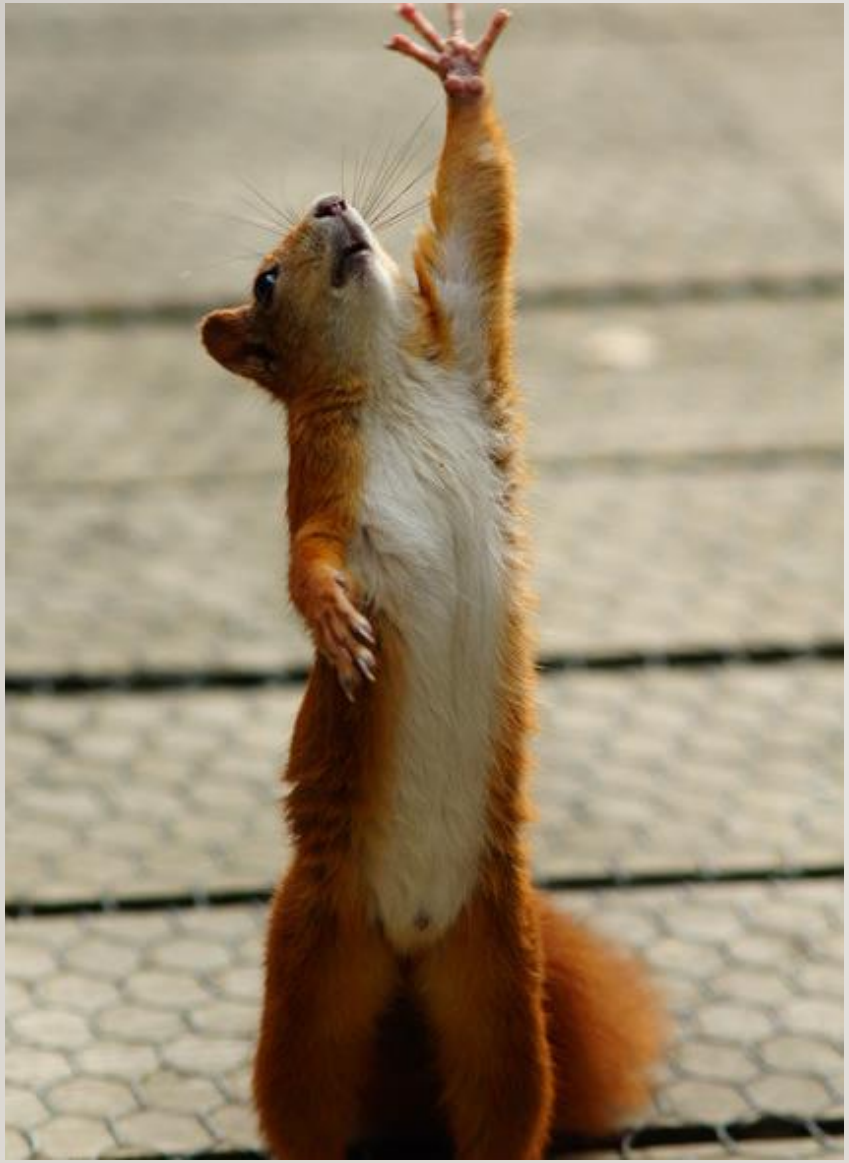
ADJUSTMENTS BASED FROM ABG'S

- P_{high} 24 T_{high} 3 T_{low} .5 P_{low} 0
- 7.26, 60, 64, 23
- P_{high} 24, T_{high} 2 T_{low} .4 P_{low} 0
- 7.28, 58, 62, 23,
- P_{high} 28 T_{high} 2 T_{low} .4 P_{low} 0
- 7.30, 58, 64, 24,
- P_{high} 30 T_{high} 2 T_{low} .3 P_{low} 0
- 7.32, 55, 70, 24
- **********
- P_{high} 32, T_{high} 1.0 T_{low} .3 P_{low} 0
- 7.28, 64, 60, 28, -9



WEANING

- What does this involve?
- Drop and stretch
- Decreasing P_{high}
- Increasing T_{high}

Giving the lungs time to heal

- Philippe Rola1 * and Benjamin Daxon2 noted

False Reassurance by Improved Oxygenation

These improvements were often misleading, however. Several consultants unfamiliar with APRV-TCAV™ were surprised that the patients were not being more aggressively weaned since they "clearly no longer had ARDS" based on their FiO_2 and chest X-ray (CXR). But while the lung may have been recruited and traditional parameters were improved, there was still an underlying pathology that required additional time to heal. If the P_{High} was decreased before the true alveolar stability was achieved, then the CXR would abruptly worsen and gas exchange would quickly regress. This phenomenon of needing to "stabilize" the lung after recruitment on APRV-TCAV™ has been reported elsewhere and likened to needing a cast for a period of time after setting a fracture (Nieman et al., 2018). Hence, clinicians will have to carefully observe patients' breathing patterns, ventilator curves, and gas exchange during weaning.

- Things we used to say, what is still true???
  - Permissive hypercapnia with pH of ≥ 7.25 is often tolerated in APRV
  - *Yes, with traditional settings, we can RESCUE with TCAV settings*
  - Spontaneous breathing is encouraged and helps with ventilation (CO2 removal)
  - *Yes, with traditional settings, Maybe not when using TCAV*
  - Avoid deep sedation
  - *Yes, with traditional settings, Maybe not when using TCAV*
  - Less ventilation (releases) may lead to less VILI
  - *Yes, if your pt. can tolerate it*
  - Wean P_{HIGH} after lungs are recruited
  - *Yes, but be careful with rebound, look at your diaphragm curvature*
  - Maximum benefit may take up to 8 hours
  - *Absolutely, even with TCAV*
  - If patient has a very high CO2, they may either need to spontaneously breathe or the settings will have to be adjusted to give them more releases for CO2 removal
  - *Absolutely with traditional, hopefully when utilizing TCAV we can avoid high CO2*

BIG TAKE AWAYS

- You can use traditional APRV
- You can use the TCAV method, especially for rescue
- I now believe in setting T_{low} to 75% knowing that there is always the exception
- P_{low} should be set at 0
- Give the lungs time to stabilize and heal after recruitment

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THANK YOU!!

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