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

Make adjustments based on arterial blood gas results

Recommend appropriate initial settings for APRV both traditional and using the TCAV method
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

- $P_{\text{high}}$
- $T_{\text{high}}$
- $T_{\text{low}}$
- $P_{\text{low}}$
Traditional APRV initial settings

\[ P_{\text{high}}: \ 20-25 \ \text{cmH}_2\text{O} \quad \text{(30 cmH}_2\text{O max)} \]

\[ T_{\text{high}}: \ 4-5 \ \text{seconds} \]

\[ P_{\text{low}}: \ 0 \ \text{cmH}_2\text{O} \]

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

\[ \text{FiO}_2: \ 100\% \ \text{and reduce to <60\% as tolerated} \]
GOALS

• pH ≥ 7.25 ≤ 7.45
• PaCO$_2$ < 60 mmHg
• PaO$_2$ 55-80 mmHg
• SaO$_2$ > 88%
• FiO$_2$ <50%
• Pplat < 30 cmH$_2$O
LET’S DIVE INTO TCAV
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

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### Specific TCAV \( T_{\text{HIGH}} \) & \( T_{\text{LOW}} \) Settings

| \( T_{\text{High}} \) (seconds)** | Set to match rate on mode transitioning from using the formula: 
\( \frac{60}{\text{current rate}} - T_{\text{Low}} \) (i.e. rate 26; \( \frac{60}{26} = 2.3 \))
If \( T_{\text{Low}} \) is 0.5, then \( T_{\text{High}} \) would be set to 1.8 seconds |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>( T_{\text{Low}} ) (seconds)*** set to ( E_{\text{SI}}/E_{\text{IP}} ) of 75%.</td>
<td></td>
</tr>
</tbody>
</table>

**NOTE:** These ranges are a starting point and may require adjustment to achieve \( E_{\text{SI}}/E_{\text{IP}} \) of 75%.

<table>
<thead>
<tr>
<th></th>
<th>Adults - 0.3-0.6</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pediatrics – 0.2-0.5</td>
</tr>
<tr>
<td></td>
<td>Neonates – 0.2-0.3</td>
</tr>
</tbody>
</table>

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SETTING EXPLANATION ACCORDING TO THE TCAV NETWORK

**P\text{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\text{low}** - Set at 0 due to the release set to terminate at 75% of E\text{FP}.

**T\text{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\text{low}** - is the duration of the release phase and controls the amount of airway pressure (P\text{high}) and lung volume to be released. T\text{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%

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ADJUSTING $T_{\text{LOW}}$ TO 75%
ADJUSTING $T_{\text{LOW}}$ TO 75%
• https://www.tcavnetwork.org
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).

<table>
<thead>
<tr>
<th>Initial Settings – adjustment to settings are based on analysis of MVV, slope angle and blood gases</th>
<th>Normal</th>
<th>Mild</th>
<th>Moderate</th>
</tr>
</thead>
<tbody>
<tr>
<td>$P_{hgh}$ (cmH$_2$O) ** Set based on degree of acute lung pathology (i.e. atelectasis, edema, etc.)</td>
<td>15-19</td>
<td>20-24</td>
<td>24-29*</td>
</tr>
<tr>
<td>$P_{low}$ (cmH$_2$O) ** Consider rate required based on respiratory/metabolic acidosis. NOTE: Use these ranges as a starting point and adjust based on blood gas.</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>$T_{hgh}$ (seconds) *** Set to $E_{TV}/E_{TV}$ of 75%. NOTE: These ranges are a starting point and may require adjustment to achieve $E_{TV}/E_{TV}$ of 75%.</td>
<td>2.4</td>
<td>2.3</td>
<td>1.3</td>
</tr>
<tr>
<td>$T_{low}$ (seconds) *** These are ranges for initial $T_{low}$ settings. The $T_{low}$ setting that achieves $E_{TV}/E_{TV}$ of 75% may be higher or lower than these initial suggested ranges.</td>
<td>0.4-0.6</td>
<td>0.3-0.5</td>
<td>0.2-0.4</td>
</tr>
</tbody>
</table>

* A $P_{hgh}$ greater than 29 cmH$_2$O may be required depending on body habitus and with increased chest wall elastance.

** When transitioning to Rescue TCAV, VT typically decreases to <5mL/kg resulting in a lower minute ventilation (MVV). In this case increase the (MVV) by (decreased $T_{hgh}$ i.e. (rate) to achieve or exceed previous MVV. DO NOT increase MVV by increasing $T_{hgh}$ unless $E_{TV}/E_{TV}$ is >75% as this will decrease alveolar stability. If VT is <3mL/kg consider increasing $P_{low}$ or a combination of increased $P_{hgh}$ and decreased $T_{hgh}$. As the lung recruits (compliance improves), MVV requirements decrease allowing the $T_{hgh}$ to be increased.

*** These are ranges for initial $T_{low}$ settings.

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ADJUSTMENTS BASED FROM ABG’S

• $P_{\text{high}} 24$, $T_{\text{high}} 3$, $T_{\text{low}} .5$, $P_{\text{low}} 0$
• $7.26$, $60$, $64$, $23$
• $P_{\text{high}} 24, T_{\text{high}} 2$, $T_{\text{low}} .4$, $P_{\text{low}} 0$
• $7.28$, $58$, $62$, $23$
• $P_{\text{high}} 28$, $T_{\text{high}} 2$, $T_{\text{low}} .4$, $P_{\text{low}} 0$
• $7.30$, $58$, $64$, $24$
• $P_{\text{high}} 30$, $T_{\text{high}} 2$, $T_{\text{low}} .3$, $P_{\text{low}} 0$
• $7.32$, $55$, $70$, $24$

• $P_{\text{high}} 32$, $T_{\text{high}} 1.0$, $P_{\text{low}} 0$
• $7.28$, $64$, $60$, $28$, $-9$
WEANING

- What does this involve?
- Drop and stretch
- Decreasing $P_{\text{high}}$
- Increasing $T_{\text{high}}$
Giving the lungs time to heal

• Philippe Rola1 * and Benjamin Daxon2 noted
• Things we used to say, what is still true???

• Permissive hypercapnia with pH of $\geq 7.25$ 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


• https://www.tcavnetwork.org

• Airway Pressure Release Ventilation With Time-Controlled Adaptive Ventilation (TCAVTM) in COVID-19: A Community Hospital's Experience Philippe Rola1 * and Benjamin Daxon2 1 Intensive Care Unit, Santa Cabrini Hospital, Montreal, QC, Canada, 2 Mayo Clinic, Rochester, MN, United States

• The time-controlled adaptive ventilation protocol: mechanistic approach to reducing ventilator-induced lung injury Michaela Kollisch-Singule 1, Penny Andrews2, Joshua Satalin1, Louis A. Gatto1,3, Gary F. Nieman1 and Nader M. Habashi2

• Early application of airway pressure release ventilation may reduce the duration of mechanical ventilation in acute respiratory distress syndrome Yongfang Zhou 1, Xiaodong Jin 1, Yinxia Lv 1, Peng Wang 1, Yunqing Yang 1, Guopeng Liang 1, Bo Wang 1, Yan Kang 2
THANK YOU!!

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