New Modes: Are we making a difference
Terry L. Forrette, M.H.S., RRT

New Modes and Ventilation Strategies: Are we making a difference?
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1st Published Scientific Paper on Mechanical Ventilation

“But that life may ... be restored to the animal, an opening must be attempted in the trunk of the trachea, in which a tube of reed or cane should be put; you will then blow into this, so that the lung may rise again and the animal take in air. ... And as I do this, and take care that the lung is inflated in intervals, the motion of the heart and arteries does not stop...”
Andreas Vesalius, 1543

Evolution of Volume Ventilation
Fell-O’Dwyer Device (1888)
Hook - 1600s

Ventilation Gets Hi-Tech

Breath Type Characteristics

**Volume**
- Guaranteed Volume
- Flow limited by settings
- Uneven gas distribution
- Barotrauma ??

**Pressure**
- Volume guarantee
- Variable flow with improved synchrony
- Better slow space ventilation
- Shear stress ??

Look How Far We Come. So What’s Next On The Horizon?

Wisdom is knowledge applied

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Wave Forms

Sensitivity versus Synchrony

- Sensitivity - trigger effort
  - Demand valve design and trigger type
- Synchrony - matching flow to demand
  - Selection of mode and flow pattern

Putting the patient in control

Work to Trigger (Sensitivity)

Matching Flow to Demand

Asynchrony Case Study

Mr. JC demonstrated asynchrony with VC breaths. Graphics showed flow deprivation and excessive triggering efforts. The patient’s erratic ventilation generated AutoPEEP, increased WOB (1.24), and tachycardia. Adjusting pre-set flow and sensitivity were not helpful. When he was placed in PC mode his VE stabilized with a return to normal WOB and a total absence of AutoPEEP.

Comments: This patient has erratic inspiratory flow demands and required variable inspiratory flows during mechanical breaths. The VC mode, with its set flow rate, was unable to satisfy the patient’s demand. Flow in PC is variable and will change in response to patient demand. Once flow needs were satisfied, the patient WOB and erratic ventilatory pattern were resolved.

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Even Gas Distribution
PCV with Decelerating Waveform

The Problem: Conventional Ventilation

The Solution:
Try a decelerating flow pattern with constant pressure

All this is fine but...

- When should I recommend PCV?
- How do I explain it to the doctors?
- What about tidal volume delivery?

What About the Dual Modes?

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If compliance decreases the pressure increases to maintain the same $V_T$

As compliance changes - flow and $V_T$ change

They start out looking like PCV

Pressure then raises to assure that the set tidal volume is delivered if C or Raw change

Pressure will decrease as necessary to assure that the set tidal volume is not exceeded

Characteristics Of A Dual Mode Ventilator Breath

- Variable inspiratory flow with a decelerating pattern
- Constant “regulated” pressure
- Volume guarantee with changes in demand, compliance and resistance

A marriage between PC and VC Breath Types
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USA – The Melting Pot of Ventilation

What Are the Actual Advantages of a Dual Mode?
- It cures cancer, can make the blind see, and will likely end worldwide hunger in our lifetime
  
  \textbf{Sorry, but no}
- But it may ... Reduce trauma, be more comfortable, easier, and safer than conventional modes

What is APRV?
- Similar to PCV if there is no spontaneous breathing

What Is APRV?
- Similar to PCV with no spontaneous ventilation
- Substantial improvements for spontaneous breathing
  - Allows spontaneous breathing at both levels

Assisted Ventilation Breath Types

<table>
<thead>
<tr>
<th>Pressure Constant</th>
<th>Volume Constant</th>
</tr>
</thead>
<tbody>
<tr>
<td>PC</td>
<td>Volume using CMV or SIMV</td>
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<tr>
<td>PS</td>
<td>Dual Modes</td>
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<tr>
<td>BiPAP</td>
<td>VS/MMV/ASV</td>
</tr>
<tr>
<td>APRV</td>
<td></td>
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</tbody>
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Tube Compensation

What is Airway Pressure Release Ventilation (APRV)?
- Cycling between the two pressure levels that can be synchronized to patient breathing
  - predetermined time or triggered by patient effort
- The two pressure levels are called PEEP$_H$ and PEEP$_L$
- The two timing levels are T$_H$ and T$_L$

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What Is APRV?
• Substantial improvements for spontaneous breathing
  – allows spontaneous breathing at both levels
  – Better synchronization

Why Use APRV Instead of …?
• Isn’t it the same thing as PCV with PEEP or PSV with CPAP? No!
  – APRV provides less WOB at the high pressure level and improved synchrony between pressure levels.
• Why would I want my patient to breath spontaneously at the high pressure level?
  – Promotes a more physiological distribution of ventilation and perfusion

APRV: It is all in the name
• Original mode called APRV- Downs & Stock
• Puritan Bennett 840 - BiLevel
• Maquet Servoi - BiVent

candidates For APRV

APRV Initial Settings
• Set high and low times to establish release rate: (caution with OAD patients)
  – Starting frequency typically 15 – 20/min
• Set high and low PEEP levels to establish gradient for $V_T$ exchange
  – Use protective lung strategies in determining lung volumes ($V_t$, 6 – 8 mL/kg)
  – Maintain $PEEP_0$ of 0 - 5 cm H$_2$O**
  – Use open lung strategies to establish FRC and then target $P_H < 30$ cm H$_2$O
• Patient may need initial sedation

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APRV and CO₂ Adjustments
- Release rate and PEEP_{H-L} gradient are used to manipulate PaCO₂

APRV and PaO₂ Adjustments
- Use MAP as method to manipulate oxygenation
  - Increase Time_{H} to increase MAP but this also decreases release rate
  - Increase PEEP_{L} but monitor V_{E} and AutoPEEP

Withdrawal from APRV
- Managing Ventilation
  - Decrease release rate to encourage spontaneous ventilation at PEEP_{L}
  - As PEEP_{H-L} narrows the patient is moved towards a CPAP type of pattern
  - Use PSV at PEEP_{L} to assist in WOB
- Managing Oxygenation
  - Use PEEP_{L} to stabilize FRC
  - Standard FIO₂ protocol

Assisted Ventilation
- Breath Types
  - Pressure Constant
    - PC
    - PS
    - BiPAP
    - APRV
  - Volume Constant
    - Volume using CMV or SIMV
    - Dual Modes
    - VS/MMV/ASV

What The Carina Sees...
- PSV is very efficient in reducing the WOB, but what is the best level to use?
- Lower Carina Pressure
- Pressure drop shows imposed work across ET-Tube when flow is present

PS Limitations for ETT Compensation
- PS is often used to overcome ET-tube resistance
- PS may under support the WOB early in the inspiratory phase when demand is high
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ET-Tube Compensation - Automatically Adjusts Pressure To “Erase” The ET-Tube

- TC adds appropriate pressure to keep carinal pressure at preset PEEP
  - No decreased Carina Pressure

Indications for TC/ATC

- Patients who have compromised respiratory function
  - COPD, malnutrition, respiratory muscle failure
- Those who have failed previous extubation attempts
- The “difficult to wean” patient

Considerations for Selecting Ventilation Strategies and Modes

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Comments and Questions

Thank You
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