Advanced Ventilation Techniques
Terry L. Forrette, M.H.S., RRT

1. Modes and Breath Types
2. Pressure vs. Volume
3. WOB & Patient-Ventilator Synchrony
4. Knowledge Based Ventilation

Standard Modes & Breath Types

Advanced Modes & Breath Types

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It's almost time for lunch. Am I early, or is he late?

I'm going to end up on a ventilator with ARDS!

We Have All Seen This Patient
- 48 hours on vent
- PaO₂/FIO₂ 185
- 22 PaCO₂ - PetCO₂
- Increased VE requirements
- Distant to absent breath sounds

Diagnosis: ALI/ARDS

The ARDS “Solution”
- Protective Lung Ventilation Strategies
  - Minimal tidal volumes using PC
- Open Lung Ventilation
  - Alveolar recruitment maneuver

So Now It Is Decision Time
- Which Type of Ventilator? Conventional or High Frequency
- Select a Mode: CMV, SIMV or APRV
- Choose your Breath Delivery: Volume control (VC), Pressure Control (PC) or Hybrid
- Which Management Protocol? PLV, Open lung ventilation

What Are My Options?

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• Constant pressure with variable flow & volume
• Improved gas distribution
• Shear stress

• Constant volume/flow with variable pressure
• ? Slow space ventilation
• Baro and volutrauma

Even Gas Distribution
PCV with Decelerating Waveform

Lower Resistance
Higher Resistance

Paw cmH2O
-20 0 20
V LPM
120

Avoiding Over distension
More Even Gas Distribution Despite Higher Resistance

The Problem
This often occurs with constant flow in VC

...and then you end up with this

Dead Space Units

Shunt Units

Ov...
All this is fine but...

- Why not use VCV with a decelerating flow pattern?
- I am not familiar with PCV, how do I order it?
- What about tidal volume delivery?

**Dual/Hybrid* Breath Delivery**

Pressure is automatically managed by the ventilator to achieve a target tidal volume.

Depiction of a “Dual Mode” Algorithm

Dual Mode Limitations

- Variable leaks may cause problems
- Careful patient monitoring to assess fatigue
- Alarm nuisance especially with rapidly changing lung mechanics
- Practitioner unfamiliarity with PCV

<table>
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<tr>
<th>Breath Type</th>
<th>Tidal Volume</th>
<th>Flow Rate</th>
<th>Airway Pressure</th>
<th>Insp. Time</th>
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<td>set</td>
<td>set</td>
<td>varies</td>
<td>result</td>
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<tr>
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<td>set</td>
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What type …
and how much?

Physiologic Work
Airways Resistance  Elastic Work
(non-elastic work)

Restrictive Disease COPD

WOB is frequency related

WOB is frequency related

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Neuro-mechanical synchronization

Patient – Ventilator Synchrony:
Matching gas delivery to what the patient’s brain is demanding

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Termination Synchrony

The brain is saying it's time to end the breath.

Flow Synchrony

Increased demands require increased flow.

What Flow Does Your Patient Need?
- Slow Rise Time
- Moderate Rise Time
- Fast Rise Time

Why would this patient benefit from a lower rise time?
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Time and Flow Asynchrony

Pressure Support …

How much is enough?

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Knowledge Based Ventilation

Adaptive Support Ventilation (ASV)

SmartCare®

Neurally Adjusted Ventilatory Assist (NAVA)

Proportional Assist Ventilation (PAV+©)

Closing The Loop

Patient – Ventilator Synchrony

Practitioner brain

Patient brain

Information

Response

One Simple Setting

Work of Breathing

Proportional Assist Ventilation (PAV+©)

V

P

Synchrony

Increase demand

Support Pressure

Decrease demand

% Support = 30% (Patient does 30%)

PAV+ 80% with Varying Demand

V

P

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Ventilator Work Decreased to 50%

Ventilator Work Decreased to 10%

WOB Bar

Conditional Requirements
- Tube size: 6.0–10.0
- Ensure no large leaks are present (affects R and C).
- Do not use silicone breathing circuits.
- Ideal body weight is > 25 kg (not for neonates).
- No external nebulizers which add flow.

Suppose there is an improvement in compliance.

Suppose there is an increase in airway resistance

Vent = 60% of work.
Pt = 40% of work.

Vent = 70% of work.
Pt = 30% of work.

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