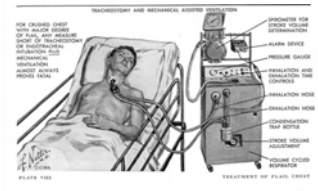
New Modes: Are we making a difference

Terry L. Forrette, M.H.S., RRT

New Modes and Ventilation Strategies: Are we making a difference?



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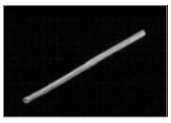
Sponsored by: Medical Specialties

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..."

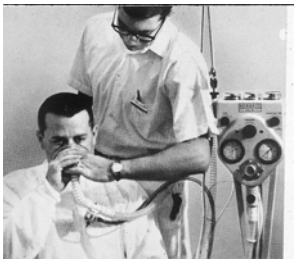
Andreas Wesele Vesalius, 1543



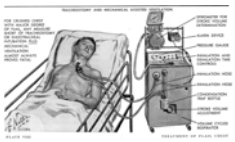
Evolution of Volume Ventilation

Hook - 1600s

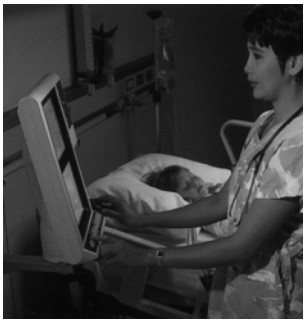
Fell-O'Dwyer Device (1888)



Ventilation Gets Hi-Tech



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



Breath Type Characteristics

Volume	Pressure
• Guaranteed Volume	• Volume guarantee
• Flow limited by settings	• Variable flow with improved synchrony
• Uneven gas distribution	• Better slow space ventilation
• Barotrauma ??	• Shear stress ??

www.tlforrette.com
forrette@yahoo.com
(504) 722-3739

Wisdom is knowledge applied

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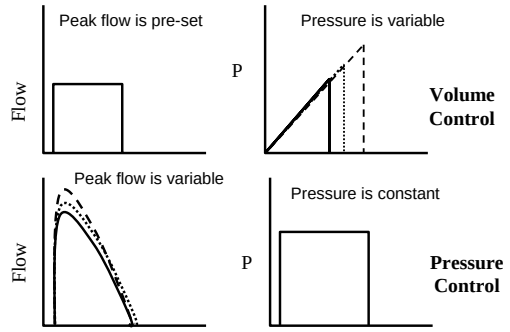
Wave Forms

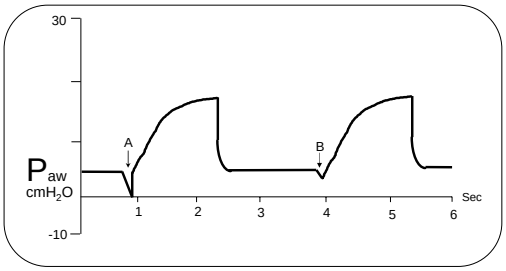


Sensitivity versus Synchrony

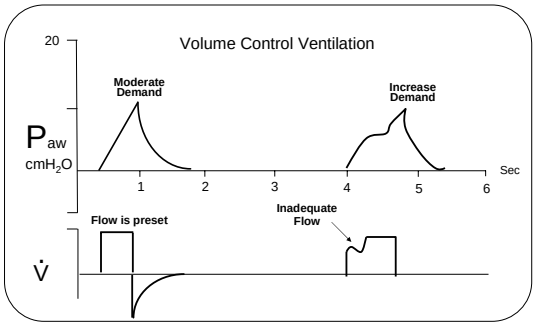
- Sensitivity - trigger effort
  - Demand valve design and trigger type
- Synchrony - matching flow to demand
  - Selection of mode and flow pattern

Putting the patient in control

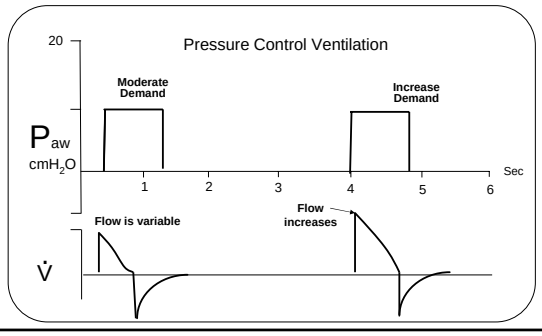
Work to Trigger (Sensitivity)



Matching Flow to Demand



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 V_E 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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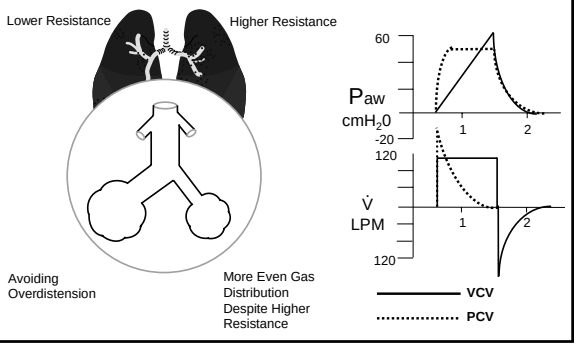
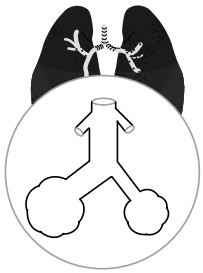
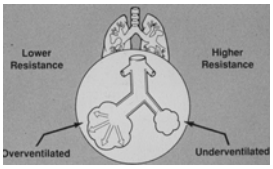
Even Gas Distribution
PCV with Decelerating Waveform



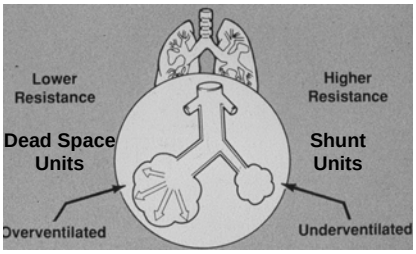


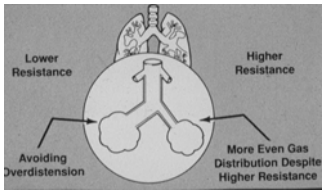
⇦ The Problem



What happens with constant flow ⇧

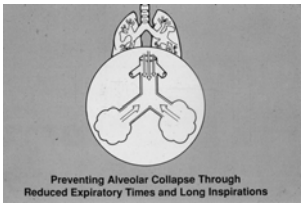
The Problem: Conventional Ventilation





The Solution:
Try a decelerating flow pattern with constant pressure

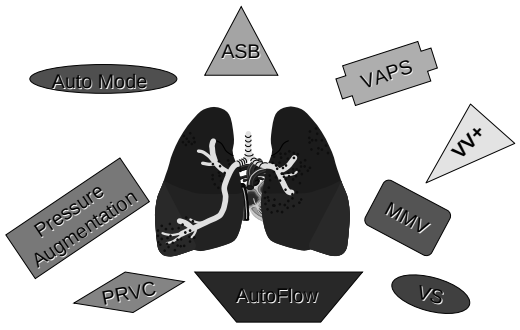
The Solution:
Prolonged inspiratory times



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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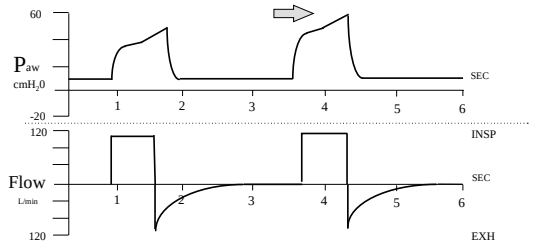
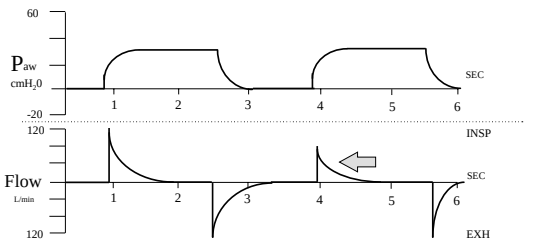
Volume Constant Breath Types

Volume Control Mandatory Breath



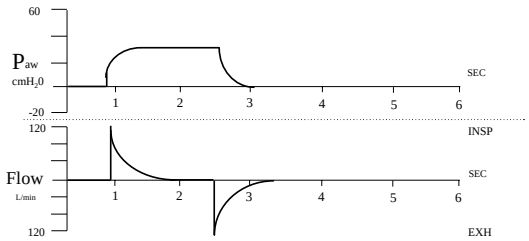
If compliance decreases the pressure increases to maintain the same V_T

Pressure Control Ventilation



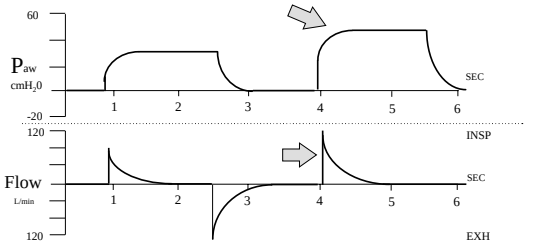
As compliance changes - flow and V_T change

Dual Mode Ventilation



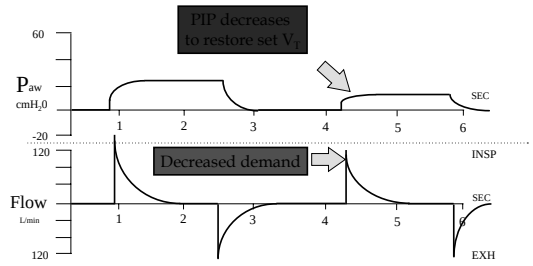
They start out looking like PCV

Dual Mode Ventilation



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

Dual Mode Ventilation



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

New Modes: Are we making a difference

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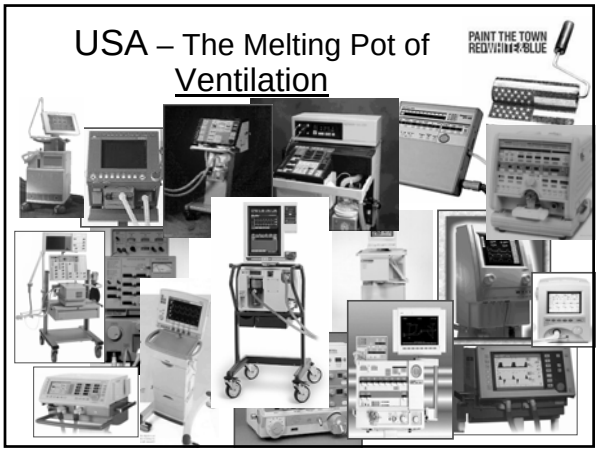
USA – The Melting Pot of Ventilation



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

SORRY, BUT NO

- But it may … Reduce trauma, be more comfortable, easier, and safer than conventional modes

Assisted Ventilation Breath Types

Pressure Constant

- PC
- PS
- BiPAP
- **APRV**

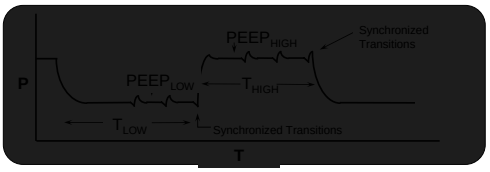
Volume Constant

- Volume using CMV or SIMV
- Dual Modes
- VS/MMV/ASV

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

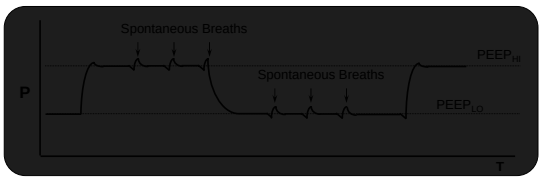


What Is APRV?

- 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**



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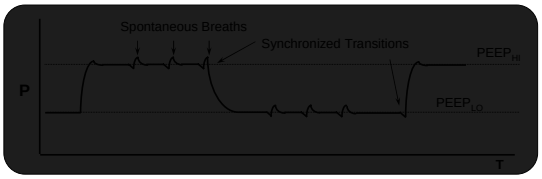
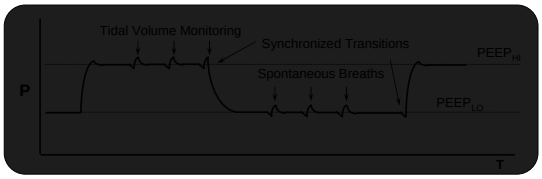
What Is APRV?

- Substantial improvements for spontaneous breathing
  - – allows spontaneous breathing at both levels
  - – **Better synchronization**



What Is APRV?

- Substantial improvements for spontaneous breathing
  - – allows spontaneous breathing at both levels
  - – better synchronization
  - – **Tidal volume monitoring of spontaneous ventilation at P_H and P_L**

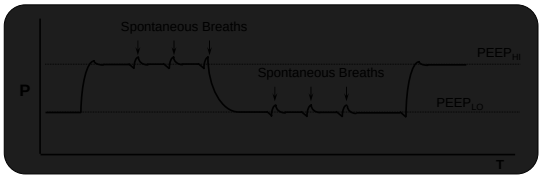


Why Use APRV Instead of …?

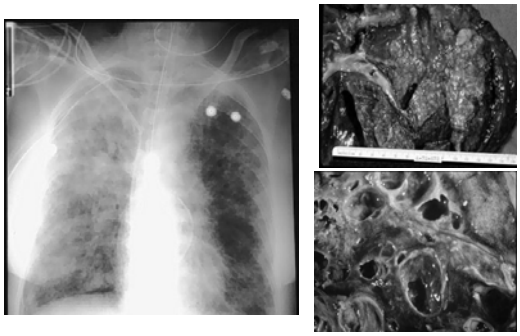
- Isn't it the same thing as PCV with PEEP or PSV with CPAP? No!
  - – ARPV provides less WOB at the high pressure level and improved synchrony between pressure levels.
- Why would I want my patient to breath spontaneously at the high pressure level?
  - – Promotes a more physiological distribution of 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 $PEEP_L$ of 0 - 5 cm H_2O**
  - – Use open lung strategies to establish FRC and then target P_H < 30 cm H_2O
- Patient may need initial sedation

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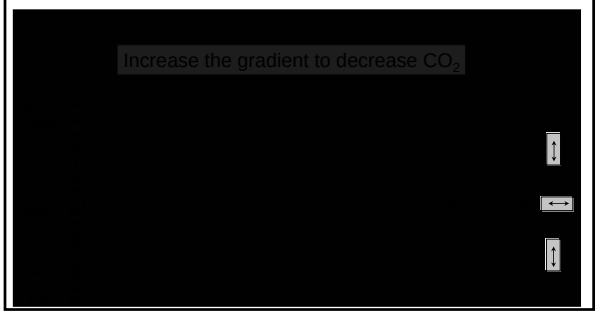
APRV and CO_2 Adjustments

- Release rate and $PEEP_{H-L}$ gradient are used to manipulate $PaCO_2$



APRV and PaO_2 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_T 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 FIO_2 protocol

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Pressure Constant

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- PS
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Volume Constant

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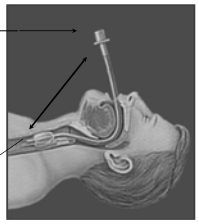
Tube Compensation

What The Carina Sees...

Circuit Pressure

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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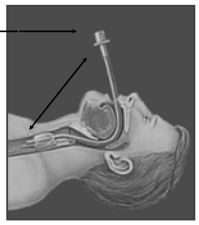
ET-Tube Compensation - Automatically Adjusts Pressure To "Erase" The ET-Tube

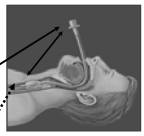
Higher Circuit Pressure

- TC adds appropriate pressure to keep carina pressure at preset PEEP

No decreased Carina Pressure



ET-Tube Compensation - Automatically Adjusts Pressure to "Erase" the ET-tube



Higher Circuit Pressure

Baseline Carina Pressure

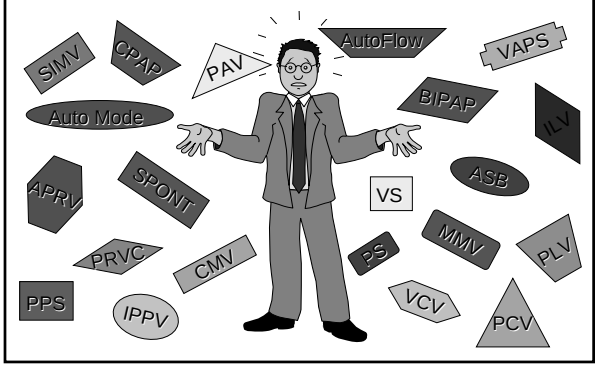
- TC adds appropriate pressure to keep carinal pressure at preset PEEP

TC Pressure Variability

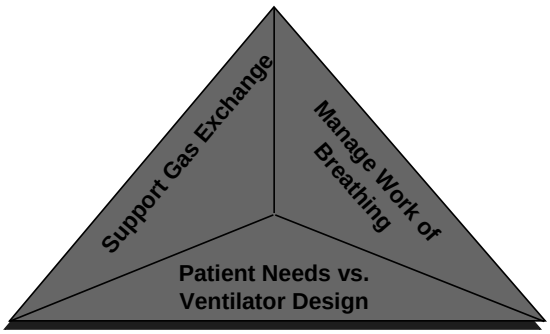
Indications for TC/ATC

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

Which One is the Best?



Considerations for Selecting Ventilation Strategies and Modes



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Comments and Questions

Thank You

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