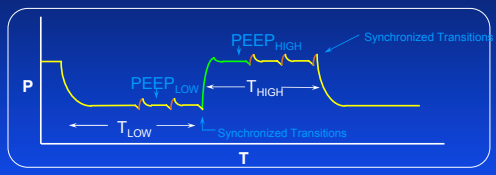
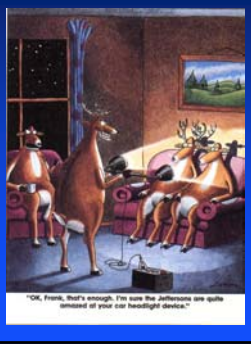
Ventilation Strategies: BiLevel Ventilation and Graphics

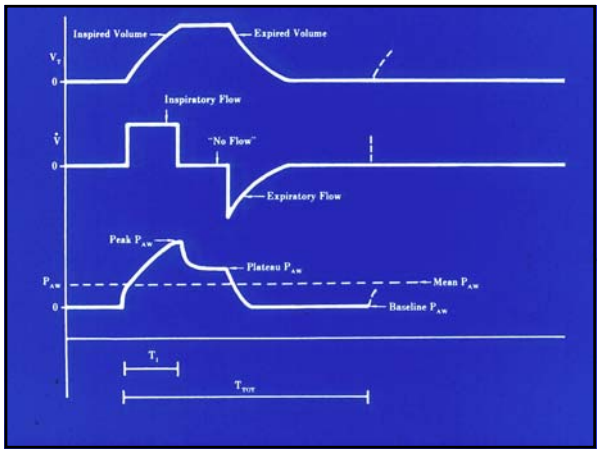


Terry L. Forrette, M.H.S., RRT

Presentation Overview

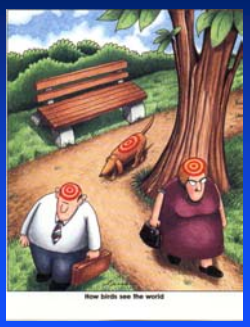


- Wave Forms and Curves
- Ventilator Management
- BiLevel/APRV
- Applications

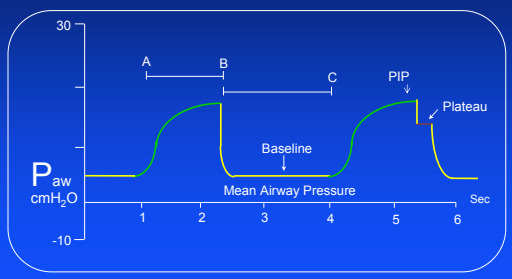


Pressure Wave Forms

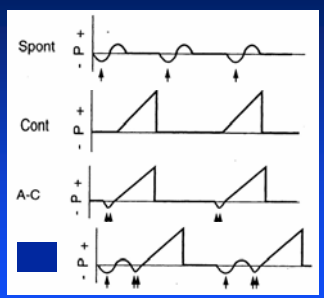
- What mode are we in?
- Differentiating sensitivity from synchrony issues
- Adjusting PC level, I:E ratio, PSV, Esen



Waveforms



Recognizing Mode of Ventilation

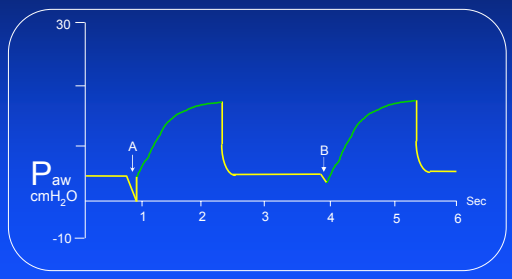


Wisdom is knowledge applied

Sensitivity versus Synchrony

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

Work to Trigger (Sensitivity)

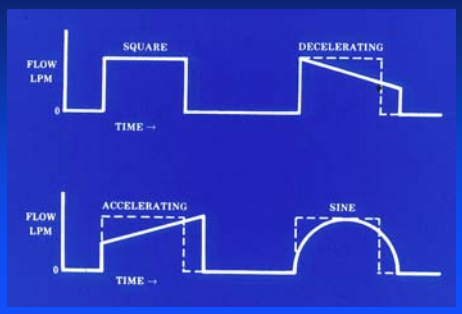


Patient / Ventilator Synchrony

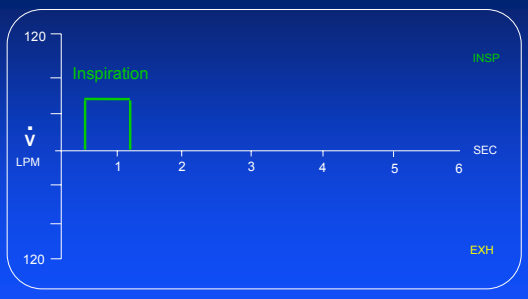
The Patient Is Out-breathing the Set Flow

What options do we have?

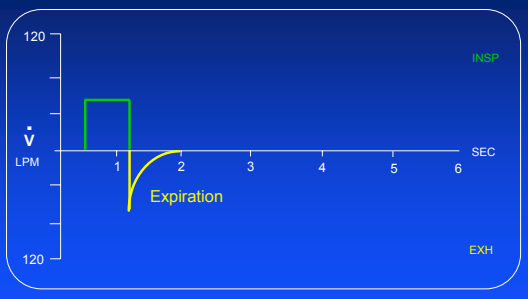
Flow Patterns



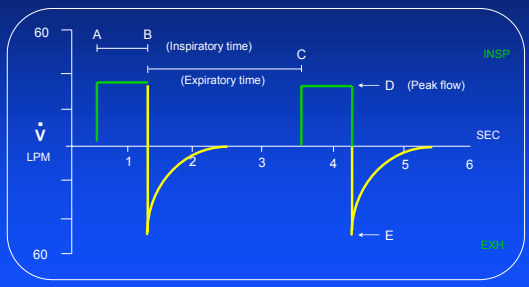
Flow-Time Curve



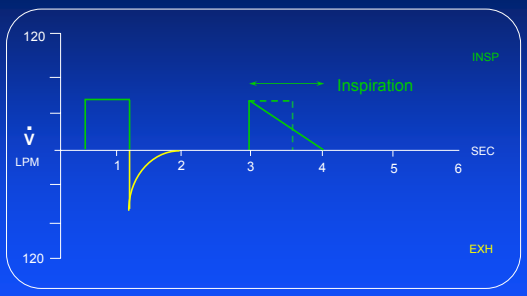
Flow-Time Curve



Typical Flow Curve



Flow-Time Curve



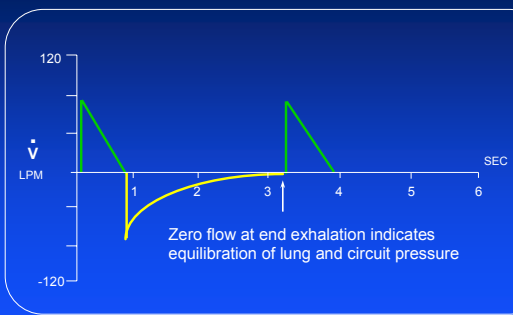
Using Flow Patterns

- Assessing Synchrony
- Selecting "best" mode of ventilation
- Identifying AutoPEEP

AutoPEEP

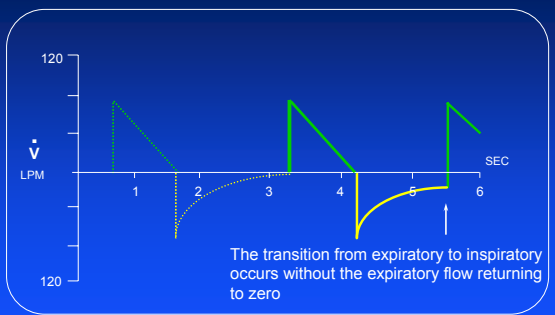
- Measures trapped air not reflected by Paw
- Influences WOB, hemodynamics and lung mechanics
- Essential during PCIRV

Detecting Auto-PEEP

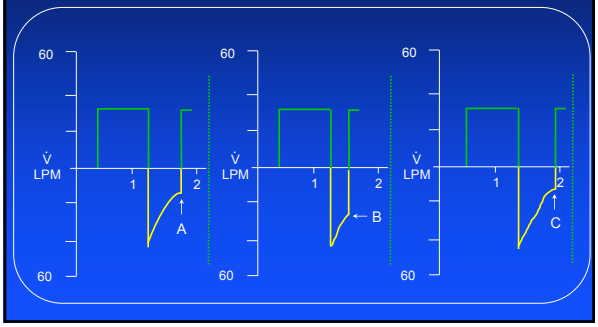


Note: There can still be pressure in the lung behind airways that are completely obstructed

Detecting Auto-PEEP

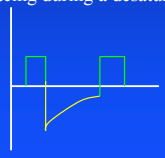


Auto-PEEP



AutoPEEP Case Study - 1

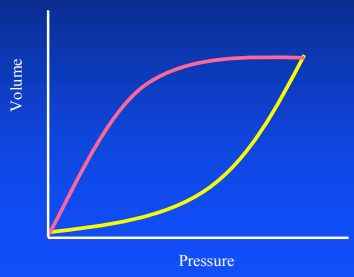
Mrs. KT suffered a CHI following an automobile accident. While being ventilated in VC, using AC, she showed erratic exhaled volumes, changes in BP, and required frequent sedation. ABG's showed moderated hypoxemia, with mild hypercapnia. Pulse oximetry was unstable and periods of desaturation were noted when the patient's exhaled V_T's became erratic. The following represents a typical flow-time tracing during a desaturation episode.

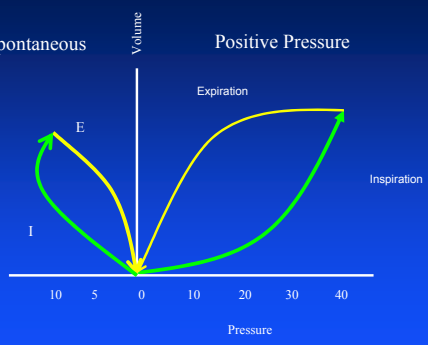


This patient was generating AutoPEEP leading to decreased S_PO_2 and erratic exhaled V_T.

Pressure - Volume Curves

A Two Dimensional View

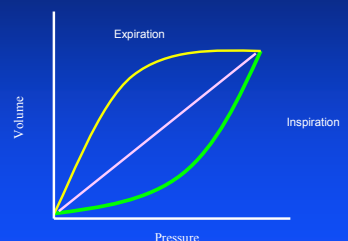


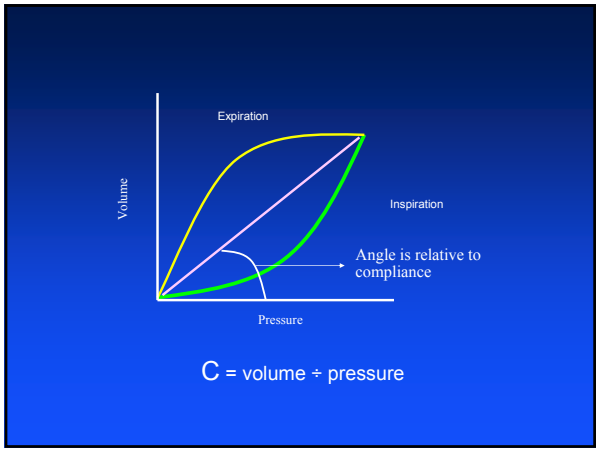


Using Pressure - Volume Curves

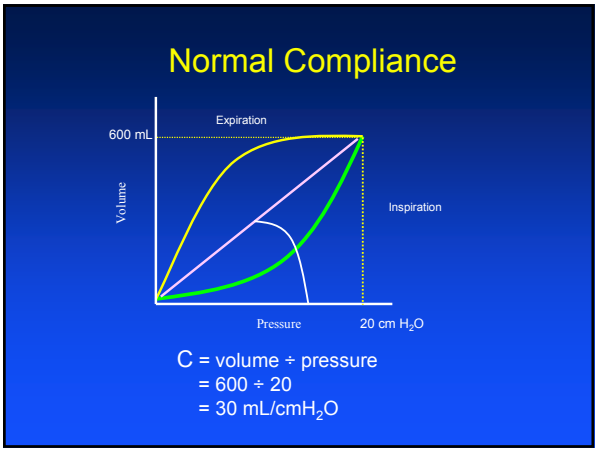
- Assessing lung mechanics
  - Compliance, airways resistance, & WOB
- Titrating ventilator settings
  - PSV, Rise time, Esen, TC
- Trouble shooting
  - Detecting AutoPEEP, circuit leaks

Pressure - Volume Curves to Assess Lung Mechanics

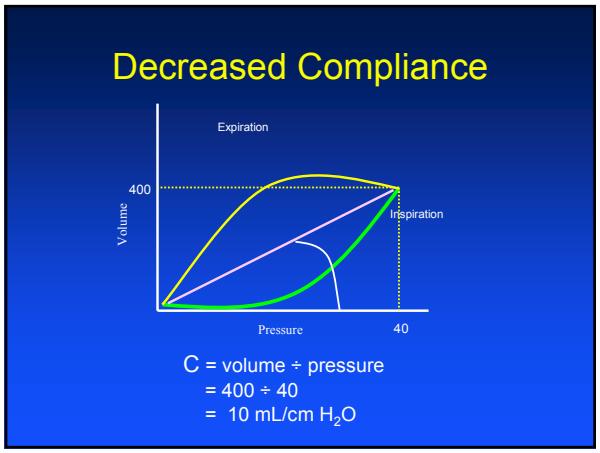




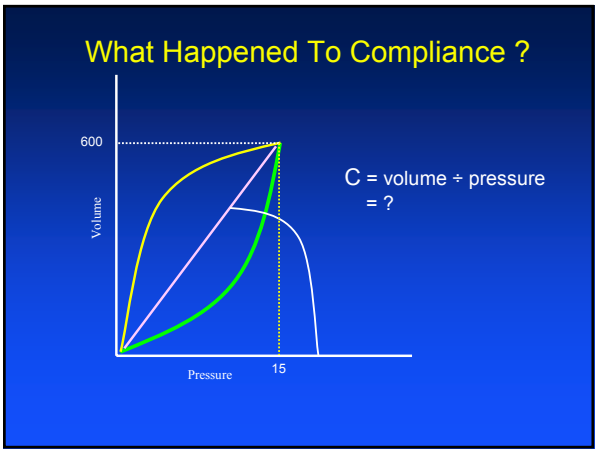
Normal Compliance



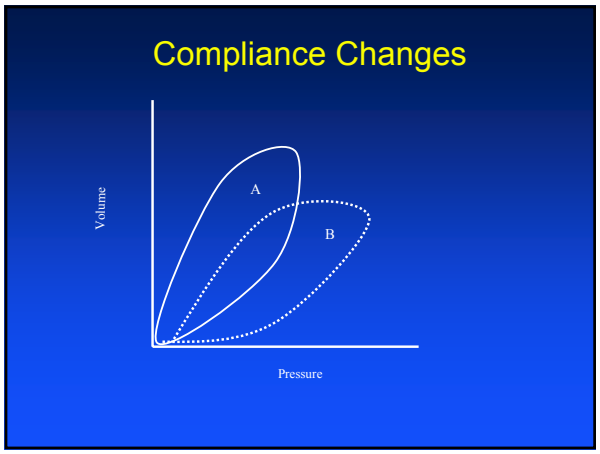
Decreased Compliance



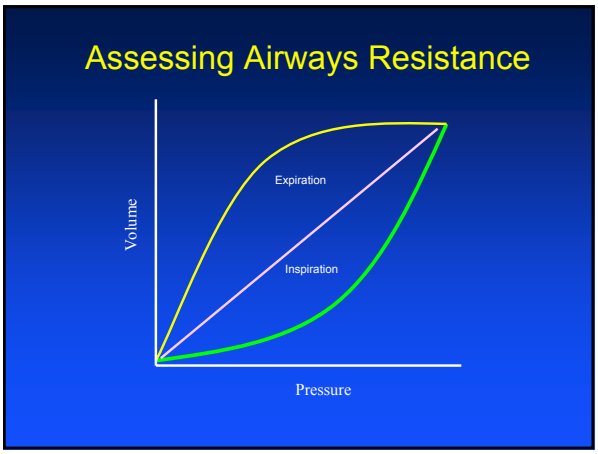
What Happened To Compliance ?



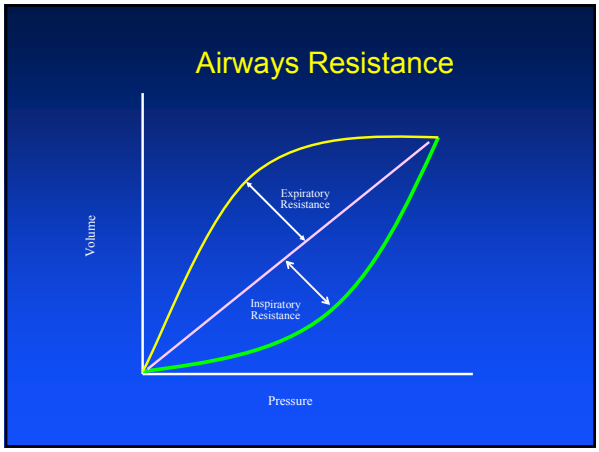
Compliance Changes

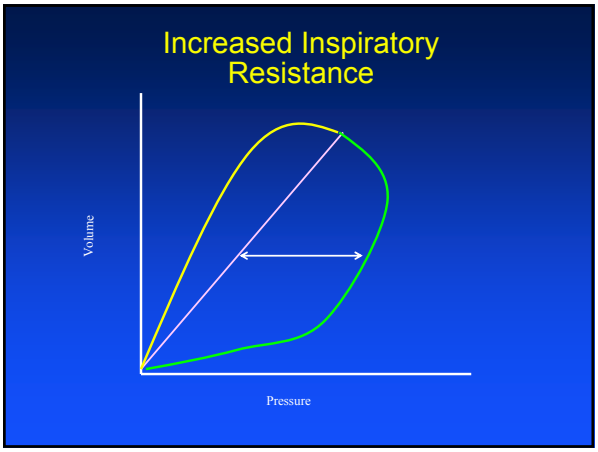


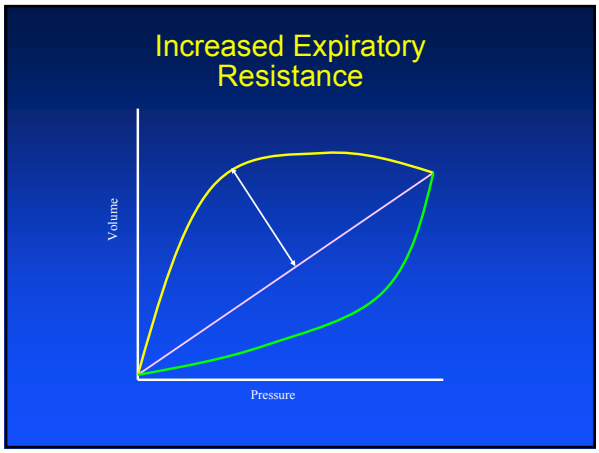
Assessing Airways Resistance

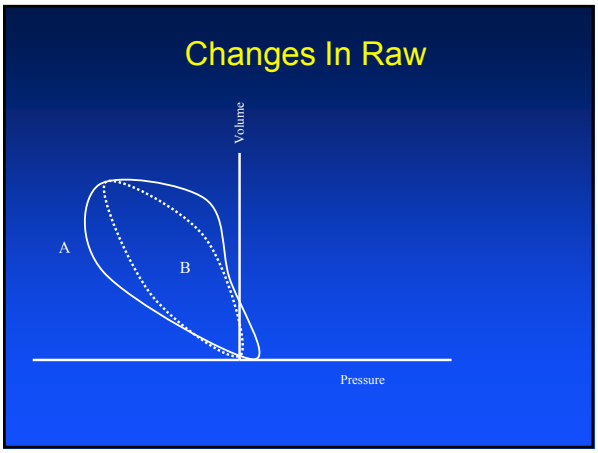


Wisdom is knowledge applied

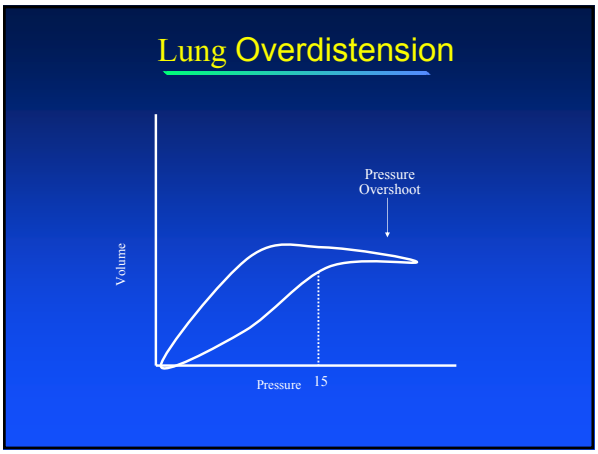

Airways Resistance
Expiratory Resistance
Inspiratory Resistance
Volume
Pressure


Increased Inspiratory Resistance
Volume
Pressure

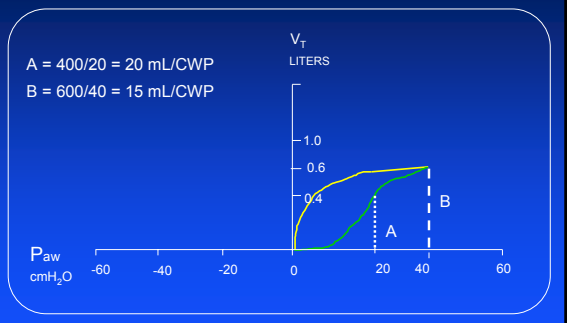

Increased Expiratory Resistance
Volume
Pressure


Changes In Raw
Volume
A
B
Pressure

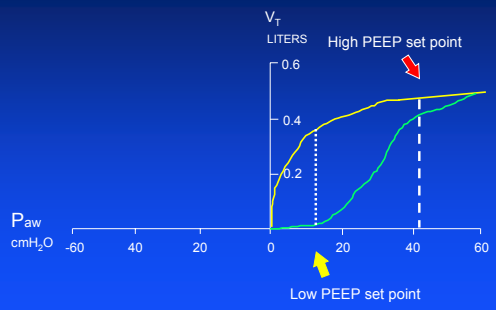

What Do We Have Here?
Big Problems!!!
Volume
Pressure


Lung Overdistension
Pressure Overshoot
Volume
Pressure
15

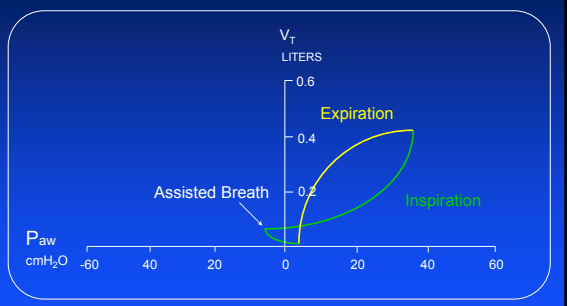
Maximizing PIP Levels



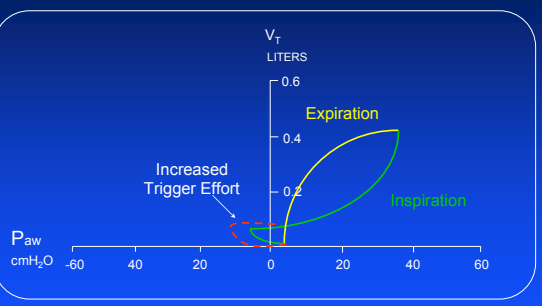
Upper And Lower Inflection Points



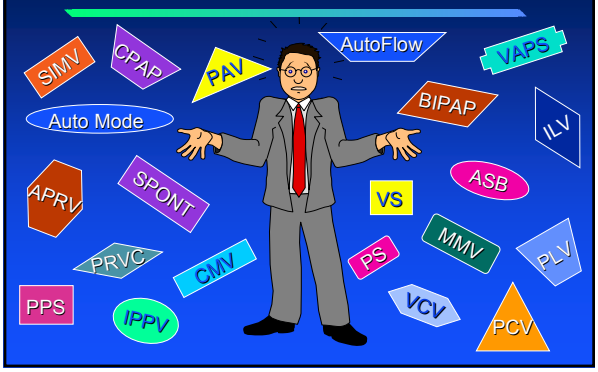
Trigger Effort



Increased Trigger Effort



What About New Modes?



Assisted Ventilation Breath Types

Pressure Constant

- PC
- PS
- BiPAP
- **BiLevel/APRV**

Volume Constant

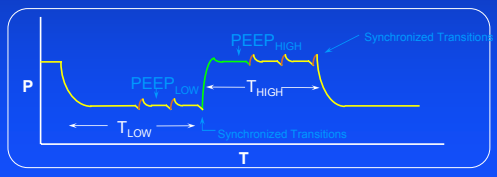
- Volume using CMV or SIMV
- Dual Modes
- VS/MMV/ASV

PAV/PPS & TC

Wisdom is knowledge applied

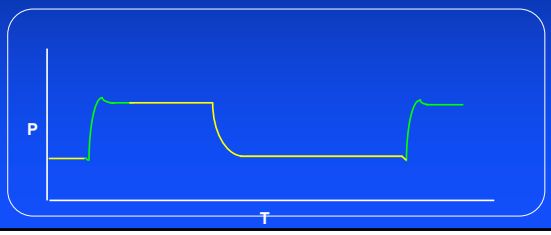
What is BiLevel?

- Cycling between the two pressure levels 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



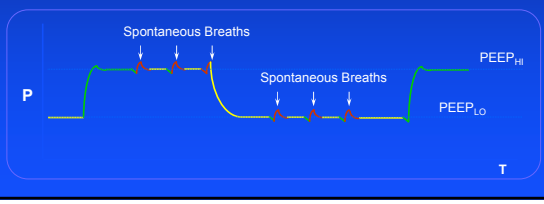
What Is BiLevel?

- Similar to PCV if there is no spontaneous breathing



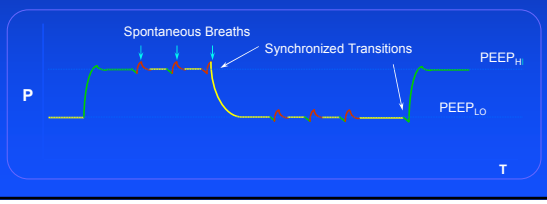
What Is BiLevel?

- Similar to PCV with no spontaneous ventilation
- Substantial improvements for spontaneous breathing
  - **Allows spontaneous breathing at both levels**



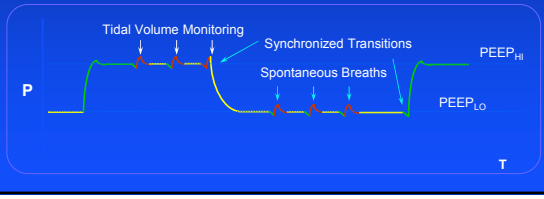
What Is BiLevel?

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



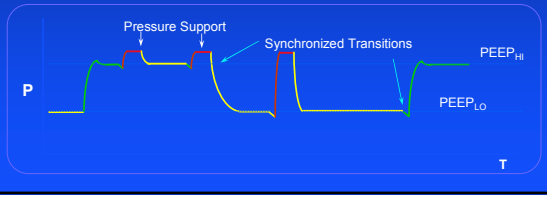
What Is BiLevel?

- Substantial improvements for spontaneous breathing
  - allows spontaneous breathing at both levels
  - better synchronization
  - **Tidal volume monitoring of upper spont breathing**



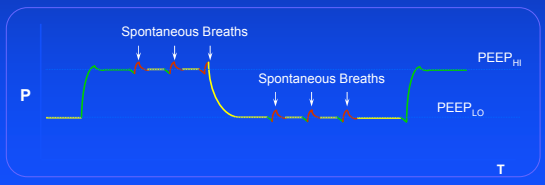
What Is BiLevel?

- Substantial improvements for spontaneous breathing
  - allows spontaneous breathing at both levels
  - better synchronization
  - tidal volume monitoring of upper spont breathing
  - **More options for supporting ventilation at upper level**

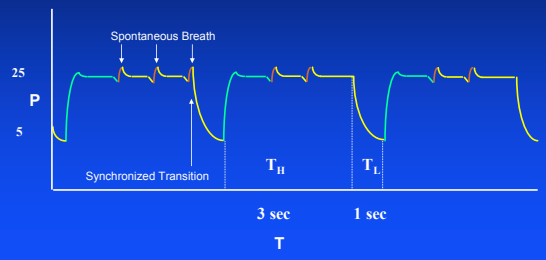


BiLevel or APRV?

- Is the "real" difference is one of terminology?
- Original mode called APRV
- Terminology is based on length of T_E and resulting I:E ratio



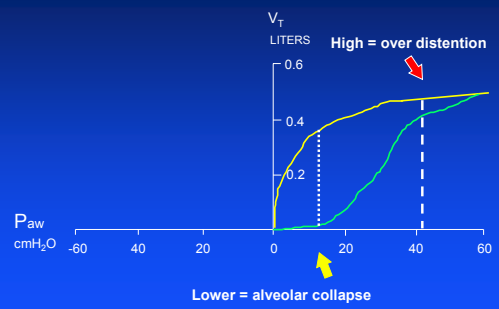
BiLevel Or APRV?



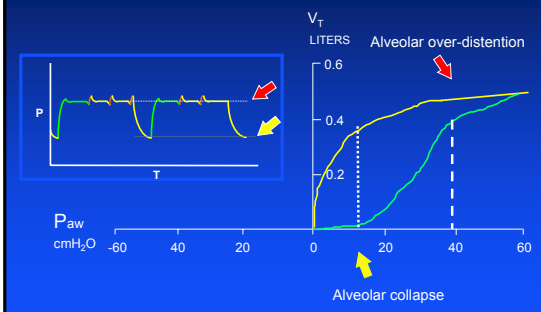
Clinical Guidelines

- Starting frequency commonly 10 - 15
- Set high and low times to establish release rate and I:E ratio
- Set high and low PEEP levels to establish gradient for V_T exchange
  - maintain $PEEP_L$ of 5 cm H_2O & keep MAP < 35 cm H_2O, P_{plat} < 30 cm H_20
  - Use inflection points to select initial pressures
- Patient my need initial sedation

Upper And Lower Inflection Points



Upper And Lower Inflection Points



Patient Management In BiLevel

- Manage oxygenation through $PEEP_L$ and ventilation with $PEEP_{H-L}$ gradient
- Reduce MAP by manipulating $PEEP_H$ $PEEP_L$ and frequency
  - As spontaneous ventilation increases, $PEEP_H$ and frequency may be reduced
  - Gradually decrease gradient to minimal settings (maintain minimal $PEEP_L$ level)
- Tailor breath delivery to maximize synchrony with Rise Time and Esens

APRV Case Study - Mr. WH

33 year old male with ARDS secondary to lung contusions. 6 days on SIMV/PSV, Cs = 17, FiO_2 .65, PIP 65, PEEP 25, V_E 22, PaO_2/FiO_2 = 186, $PaCO_2$- $PetCO_2$ = 27

PCIRV not tolerated due to necessity of NMBA

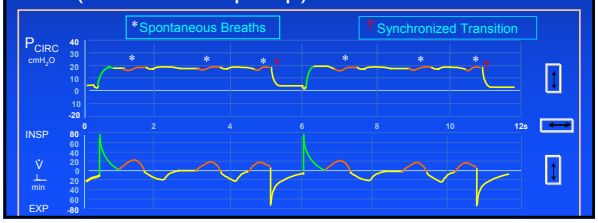
Patient placed on APRV

APRV Case Study - Mr... WH

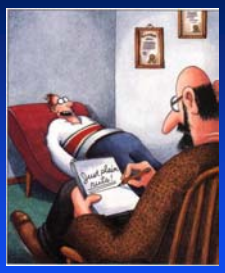
Using a high to low PEEP gradient of 30 cm (35/5) H_2O , frequency of 12 breath/min, FiO_2 .50 the following data were obtained 1 hour after APRV was started: Cs 20, PaO_2/FiO_2 237, $PaCO_2$-$PetCO_2$ 12, V_E 14. The patient had a STV of 4 mL/kg, at a rate of 15 - 20 breaths per minute. He was eventually weaned over the next several days to CPAP/PSV

Clinical Advantages

- Results in maintenance of lung volume with a lower PIP, and higher FRC at similar MAP
- Better cardiovascular performance (intrathoracic pump)



Comments and Questions



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