New Modes and New Concepts In Mechanical Ventilation

Prof Yehia Khater

Department of Anesthesia and Surgical Intensive Care
Cairo University


28 14:38

New Ventilation Modes

- **Dual Control**
  - **Within-a-breath switches from PC to VC during the breath**
    - VAPS and pressure augmentation
  - **Breath-to-Breath**
    - Pressure-Limited, Flow-Cycled Ventilation
      - Volume support ventilation VSV — Siemens 300
      - Variable-pressure-support — Cardiopulmonary corporation Venturi,
    - Pressure-Limited, Time-Cycled Ventilation
      - Pressure-regulated volume-control PRVC — Siemens 300
      - Adaptive pressure ventilation APV — Hamilton Galileo
      - Auto-flow — Draeger Evita 4
      - Volume-control — Puritan Bennett 840
      - Variable pressure control — Cardiopulmonary corporation Venturi
- **Proportional-Assist Ventilation**
- **Adaptive Support Ventilation**
- **Automatic Tube Compensation**
- **Airway Pressure-Release Ventilation**

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Agenda

1	Dual Modes
2	Volume modes with Autoflow
3	PAV
4	ATC

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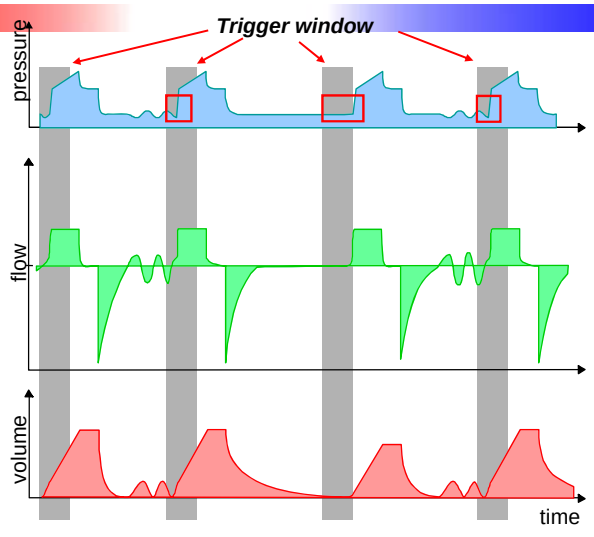
SIMV

Synchronized Intermittend Mandatory Ventilation



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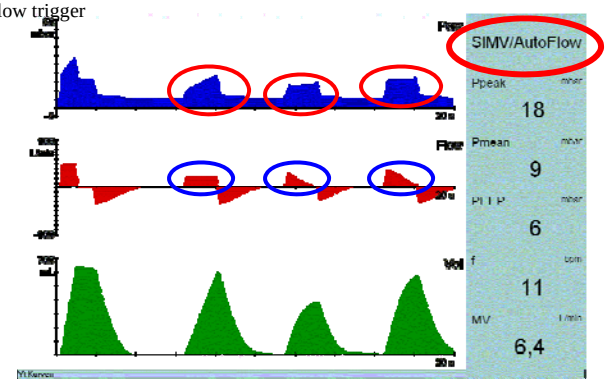
SIMV- Autoflow
Synchronized Intermittend Mandatory Ventilation

- volume controlled mode
- mandatory ventilation for patients without spontaneous breathing activities
- spontaneous breathing activities are possible ⇒ Trigger ⇒ synchronized SIMV- breath or PS above the CPAP-level
- Settings: F_iO_2, v_t, f, t_{insp}, p_{max} Flow, CPAP (PEEP), PS-level, Ramp
- add. settings: ATC, AutoFlow, Flow trigger

» AutoFlow is activated
» three test breaths
» peak pressure is cut off
» decelerating flow
» Room to breathe



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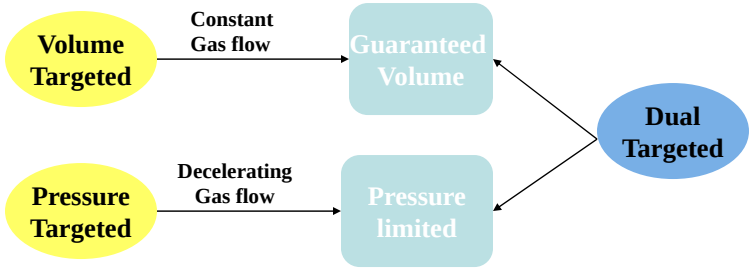
Why Dual Targeted Ventilation?

An attempt to achieve the best combination of volume and pressure targeted ventilation



A decelerating gas flow pattern is more likely to match flow demands of a critically ill patient

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Proposed advantages

- **Positive attributes of PCV or PSV**
  - Decelerating variable flow
  - Spontaneous breathing
    - Improvement of pulmonary gas exchange
    - Decrease in the work of breathing

      Putensen et al 1999, Am 1 Respir Crit Care Med *159:1241-1248*
    - Improvement in cardiovascular effects and organ perfusion (kidney, liver and splanchnic area)

      Hering and Putensen. 2000. Am J Respir Crit Care Med 161:A549

      Bonnet et al 1982 . Crit Care Med 15:106-112
- **Constant tidal volume**
- **Automatic weaning**

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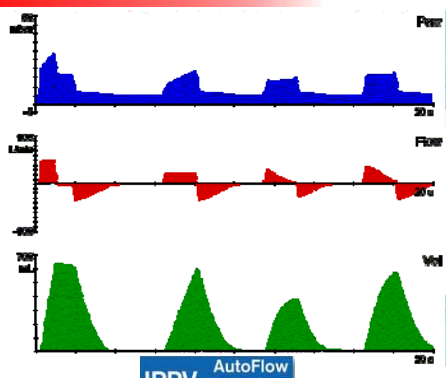
AutoFlow®
Meeting Patient's Flow Demands



IPPV AutoFlow

SIMV AutoFlow

MMV AutoFlow

Not a mode
A mode enhancement
Two features:
Open exhalation valve
Gas flow decelerating
Apply to <u>any</u> volume targeted mode

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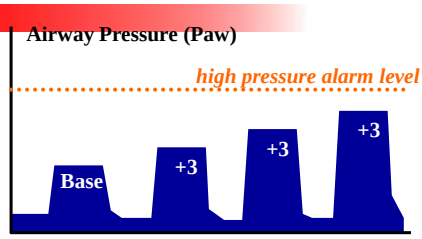
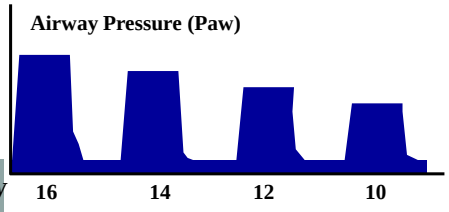
"Breath-to-Breath" Variation



Increasing pressure to maintain volume target

Worsening Compliance



Automated, decreasing pressure

Improved Compliance

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What type of lung diseases is AutoFlow® suitable for?

-Post surgical cases where acute restriction is evident

-Acute lung oedema where high airway pressures are initially acceptable but as the treatment program takes effect pressures will go down automatically and volumes will stay constant

-In cases where local atelectasis resulting from trauma or pneumonia requires frequent repositioning of the patient.

-All start up ventilation therapy scenarios where there is limited information on disease status available

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What is PAV?

- **PAV is a form of breathing support for patients whose:**
  - –Spontaneous breathing requires assistance
  - –WOB is increased as a result of
    - **higher resistance and/or**
    - **lower compliance**

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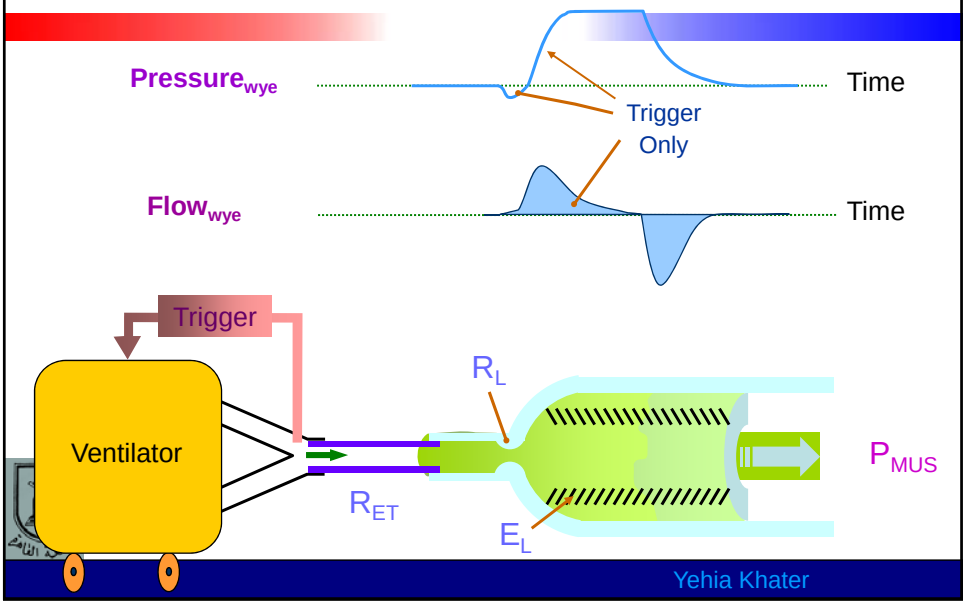
Understanding PS—Weak Effort



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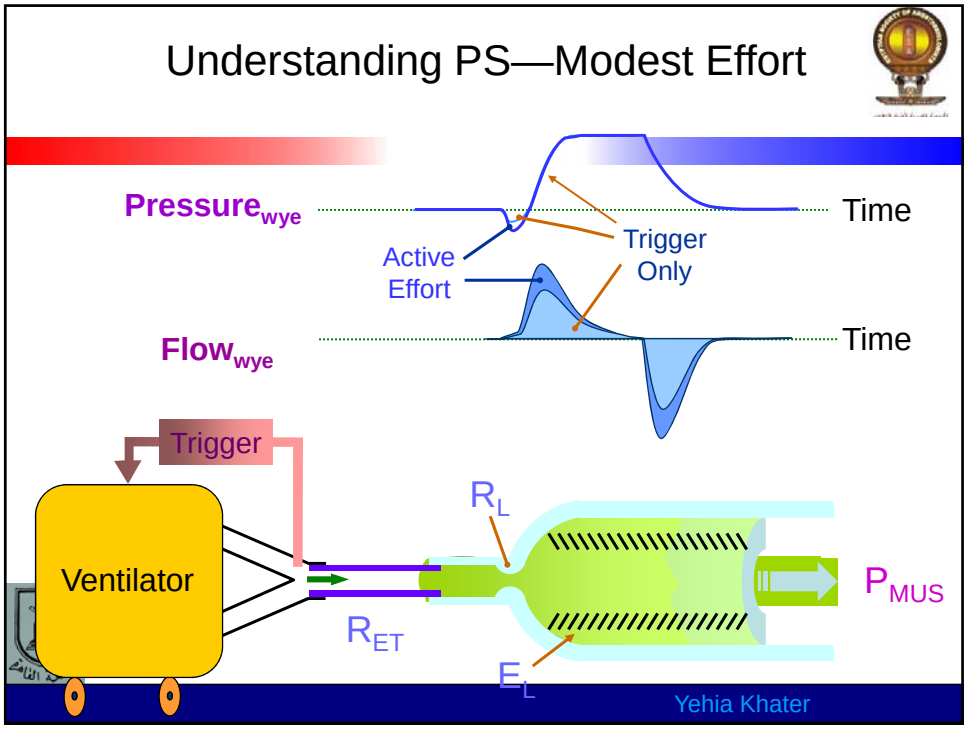
Understanding PS—Modest Effort
Pressure wye
Time
Active Effort
Trigger Only
Flow wye
Time
Trigger
Ventilator
R L
R ET
E L
P MUS
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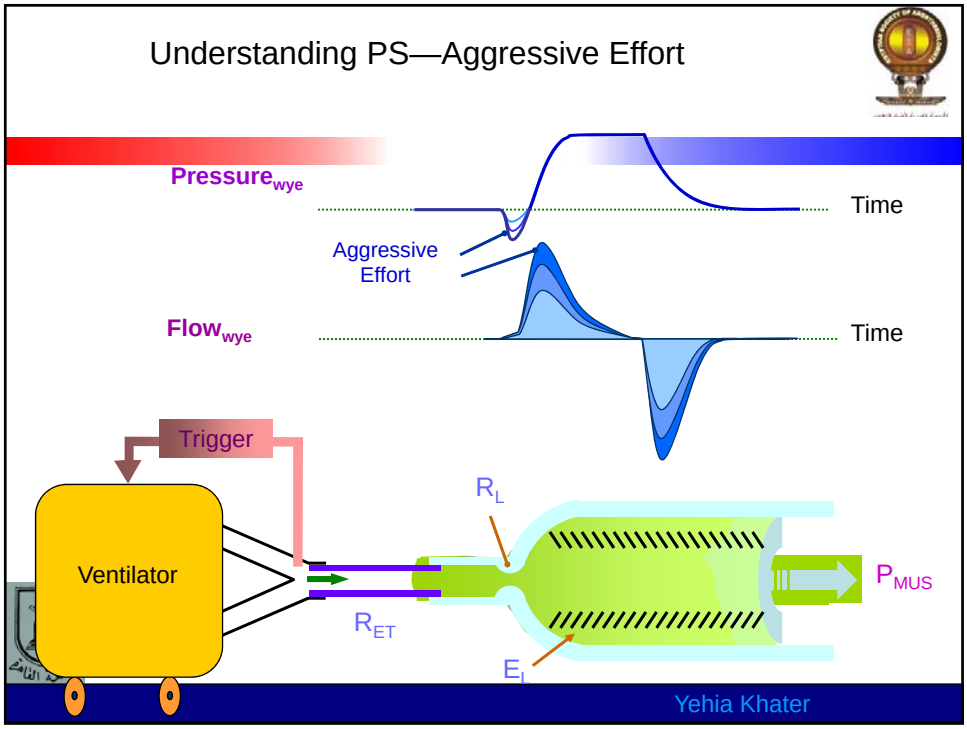
Understanding PS—Aggressive Effort
Pressure wye
Time
Aggressive Effort
Flow wye
Time
Trigger
Ventilator
R L
R ET
E L
P MUS
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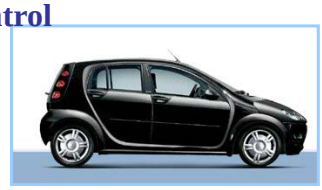
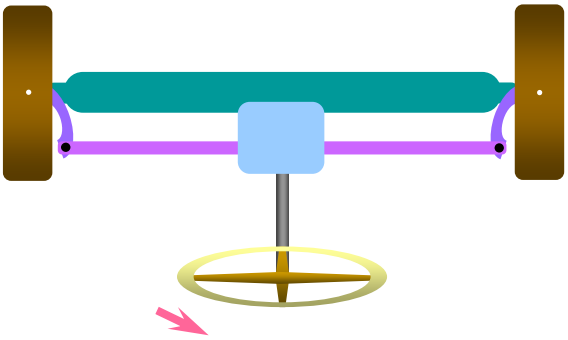
PAV And Power Steering

- How are PAV and power steering similar?
  - Both are mechanical systems that sense and then amplify muscle effort. Both share common issues regarding stability and instability (runaway)
- A small vehicle may need little or no power steering
- A large vehicle may not be steerable without power steering
- Why don't the wheels keep on turning? Because you are in control

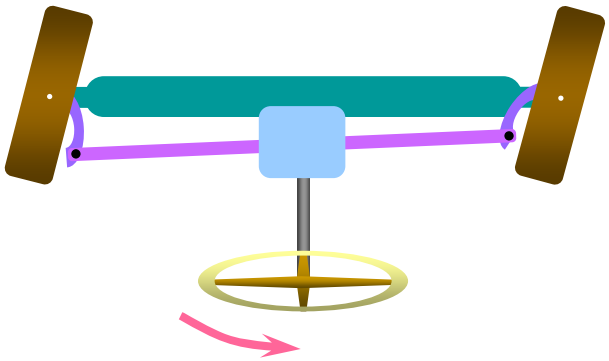


Power Steering Examined

- If power steering is a good model for PAV, let's take a look .



Power Steering Examined



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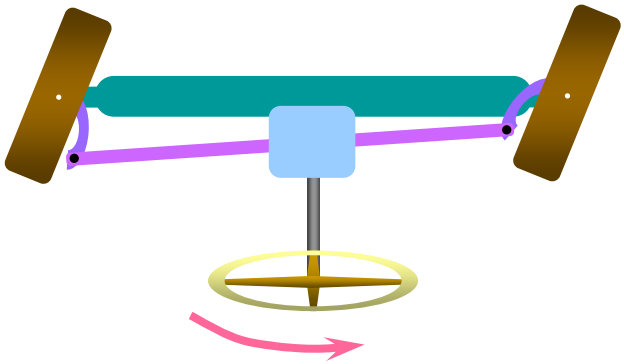
Power Steering Examined



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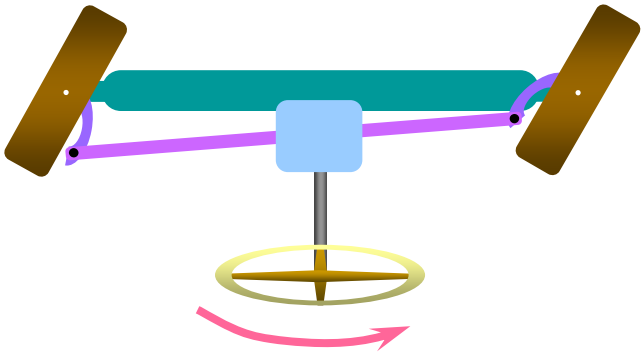
Power Steering Examined



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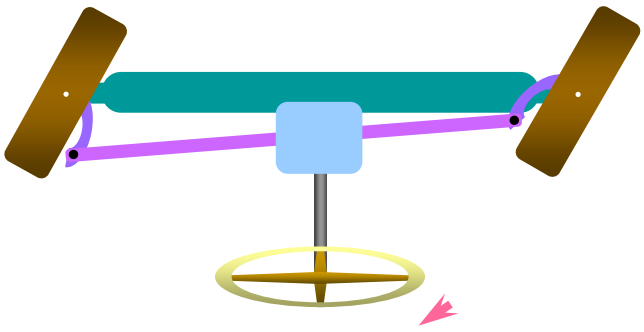
Power Steering Examined



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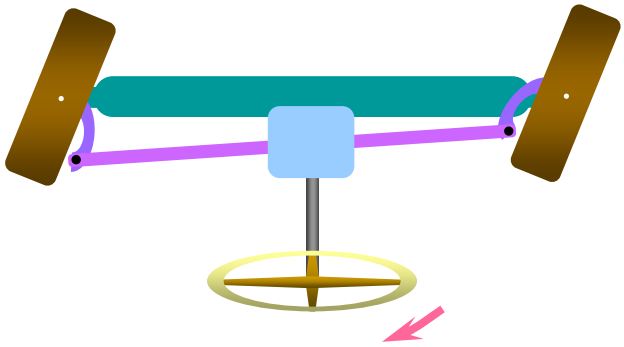
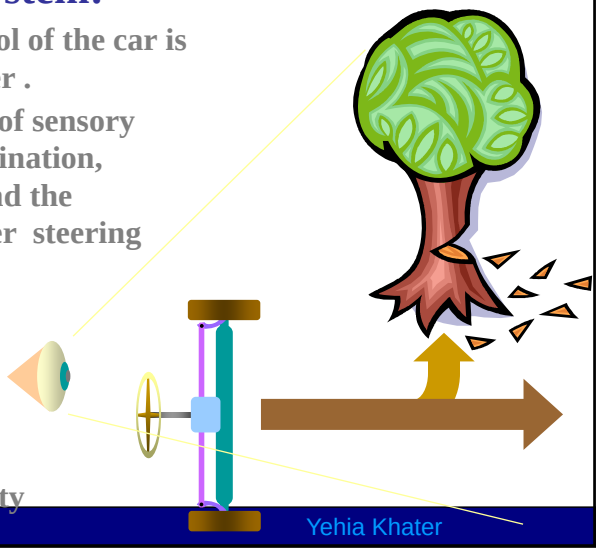
Power Steering Examined

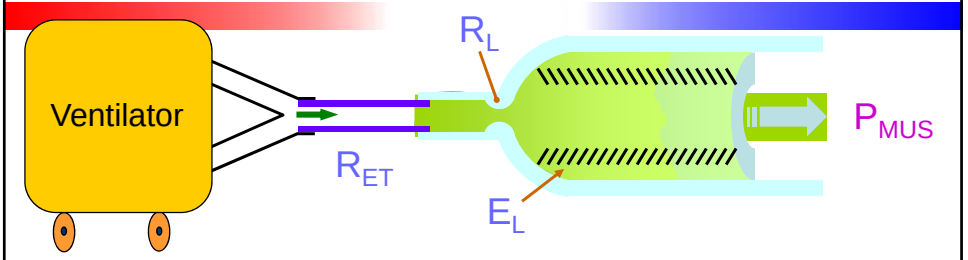


Power Steering And Stability

- **Properties of the system:**
  - The directional control of the car is managed by the driver .
  - Stability is a function of sensory input, hand-eye coordination, pattern recognition and the properties of the power steering system.
    - When neural processing is compromised (alcohol, drugs, fatigue, etc), directional stability is unlikely.



Equation Of Motion



Pressure to inflate the lung-thorax = pressure to move the gas through the airways + pressure to expand the elastic lung-thorax

$$P_{Mus}(t) = \underline{V_i(t) * R_{ET}} + \underline{V_i(t) * R_L} + \underline{V_T(t) * E_L}$$

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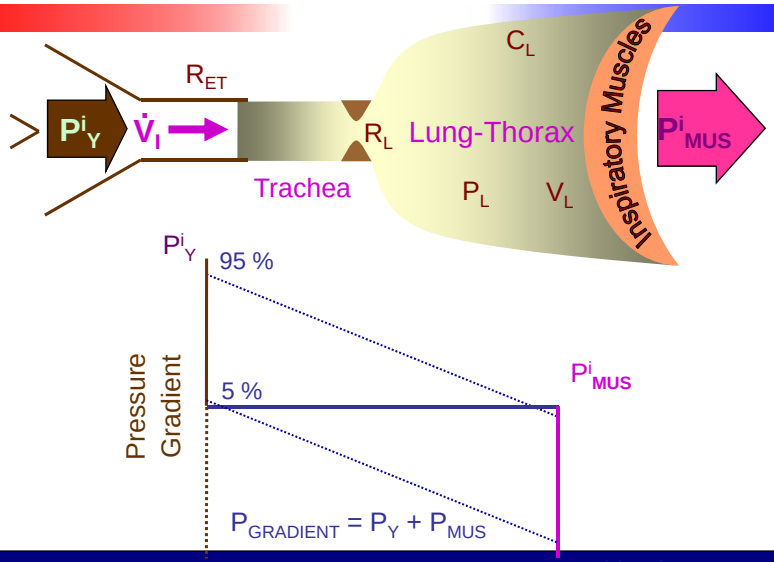
The % Support Control



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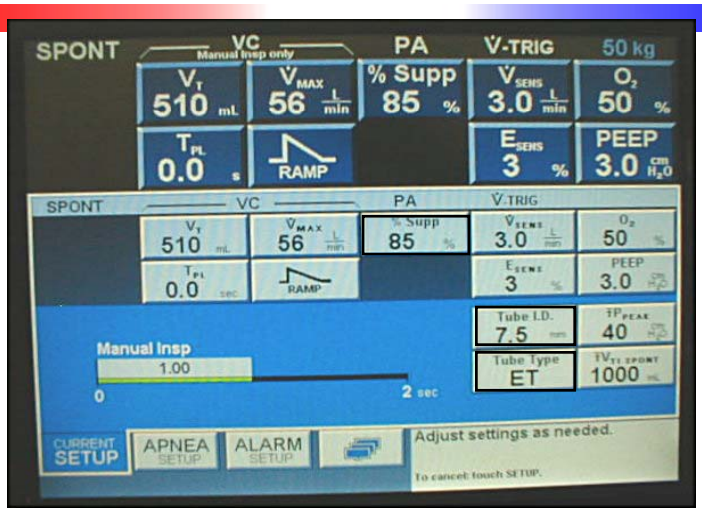
PAV+ Settings



PAV+ - Work of Breathing Bar (1)

The WOB bar gives a very clear indication to the clinician, the effectiveness of the % support selected. The % support setting should be adjusted to maintain the WOB PT indicator in the green area. If the indicator is to the left, the patient is being over-supported and if it is to the right, the patient is being under-supported. The WOB PT indicator also shows the proportion of patients inspiratory work to overcome elastance and resistance of the system

PAV+ - Work of Breathing Bar (2) Shadow Trace

The WOB TOT indicator is the estimated WOB of the patient and ventilator during inspiration. The aim is for this to also be in the green area.

The shadow trace shows the estimated lung pressure (P-lung) and the idea is this trace should match the circuit pressure trace as closely as possible

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PAV+ Patient Selection - Cardiovascular and Acid Base Status

- **Stable hemodynamic status**
- **Patient with good electrolyte balance**
- **Patient who has a good acid-base balance demonstrated by pH between 7.35 to 7.45 and pCO_2 between 45 and 55**
- **Patient in shock is not a good candidate for PAV+**

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PAV+ Warning Signs for Inadequate Ventilation

- **Respiratory rate >35**
- **SpO_2 < 90%**
- **pH < 7.35 (respiratory acidosis)**
- **Heart rate > 140/min or sustained 20 % increase in heart rate.**
- **Systolic BP >180 mm Hg, diastolic > 90 mm Hg**
- **Anxiety**
- **Diaphoresis** (visible perspiration)

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Automatic Tube Compensation (ATC)

- **Compensation of tube resistance**
  Easy to set
  - Endotracheal/ tracheostomy tube diameter
  - Compensation degree in %

- **Electronic extubation**
  Any mode !!!!!!!!!!!!!!
- **Inspiratory & Expiratory compensation**
- **Expiratory tube compensation can be switched off while inspiratory tube compensation is on**

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ATC and PSV
What is the difference ?

Difference Between ATC and PS

- **PS is a user set, fixed pressure that remains constant throughout the inspiratory phase irrespective of the patients flow rate.**
- **ATC is a user set level of compensation (0-100%). The driving pressure will vary according to the tube type, size set, compensation level and inspiratory flow rate**

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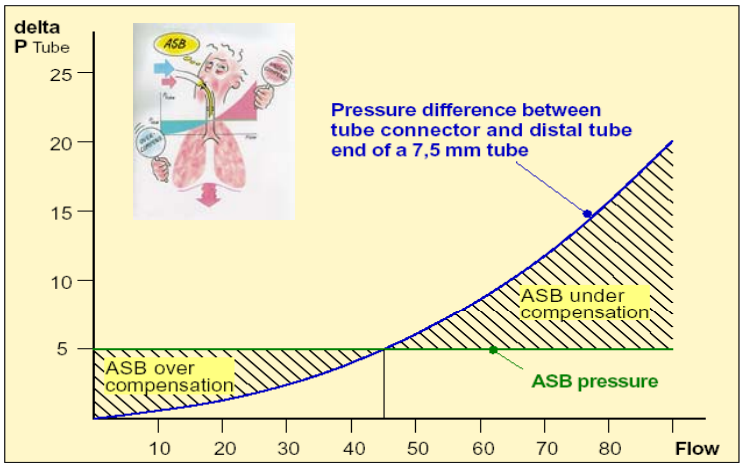
Automatic Tube Compensation
ATC vs PSV



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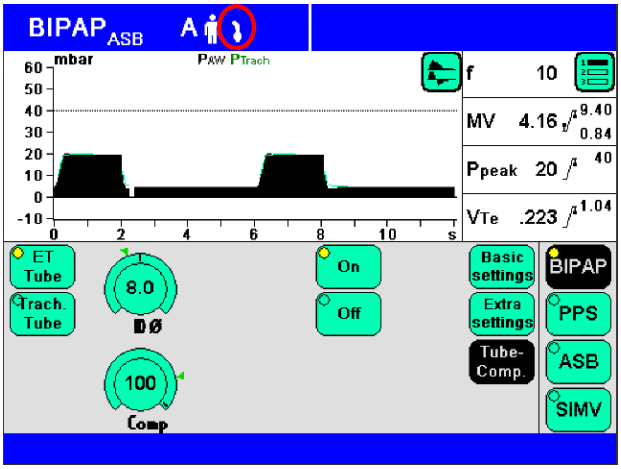
ATC - How to activate



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Thank You

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New Modes and New Concepts In Mechanical Ventilation

Prof Yehia Khater

Department of Anesthesia and Surgical Intensive Care
Cairo University

Mechanical Ventilation of Severe Sepsis

•Protective lung strategy: low Vt 4-8 ml/kg	1 B	Grade B
•P plat <30 cmH2O	1 B	Grade B
•Permissive hypercapnia	1 C	Grade C
•Best PEEP (recruitment)	1 C	Grade E
•Prone position (in places able to)	2 C	Grade E
•Semi-recombinant position 45 º decrease VAP	1 B	Grade C
•Weaning protocols SBT, T-piece or 5 PSV + 5 PEEP	1 B	Grade A
•No Routine PACP	1 B	
•Conservative fluid therapy	1 C	

Protective Lung Strategy

- Low Tidal Volume 4-8 ml/kg — 1 B
- P plat < 35 cmH_2O — 1 B
- Best PEEP — 1 C
- Permissive Hypercarbia — 1 C

Patient Management

- Semi recombinant position 45^0 ⇩VAP — 1 B
- Prone Position — 2 C
- Conservative fluid therapy — 1 C
- No Routine PCAP — 1 B

Weaning Strategy

- **SBT** — **Grade A**
- **Repeat SBT** — **Grade A**
- **Management of Failed SBT** — **Grade B**
- **Weaning protocols**
  T pieces or electronic protocols — **Grade A**

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Anesthesia, Sedation and Analgesia Neuromuscular Blockade

•Fast track extubation — Grade A

•Sedation protocol for mechanically ventilated patients with standardized subjective sedation scale target. 1 B

- **Intermittent bolus**
- **Continuous infusion with daily awakening/retitration**

•Neuromuscular blockers should be avoided due to the risk of prolonged neuromuscular blockade 1 B

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Modes allowing Spontaneous Breathing

- No conclusive evidence that CMV is more beneficial than a ventilation mode which supports SB
- On the other hand, benefits (in normal lungs, lungs with minor dysfunction and in some severe dysfunctions) of modes maintaining SB
  - **improvement of pulmonary gas exchange**
  - **decrease in the work of breathing**
  - **improvement in cardiovascular effects and organ perfusion (kidney, liver and splanchnic area) have been proven at least for some of the modes allowing SB, during application**

Putensen c., N. Mutz, G. Putensen-Him-mer, 1. Zinserling. 1999. Am 1 Respir Crit Care Med *159:1241-1248*

Staudinger T., H. Kordova, M. Roggla, P.Tesinsky, G. J. Locher, K. Laczika, S. Knapp, M. Frass. 1998.. Crit Care Med 26:1518-1522

Modes allowing Spontaneous Breathing

- CMV suppress SB activity by hyperventilation, sedation or muscle relaxation.
- Hyperventilation and respiratory alkalosis result in
  - **decrease of cardiac out put**
  - **cerebral vasoconstriction**
  - **increased oxygen consumption in tissue**
  - **broncho-constriction**
  - **significant changes in ventilation/perfusion ratio V/P**

Hudson L. D., R. S. Hurlow, K. e. Craig, D. 1. Pierson. 1985. Am Rev Respir Dis 132:1071-1074

Culpepper J. A., J. E. Rinaldo, R. M. Rogers. 1985. Am Rev Respir Dis 132:1075-1077

Modes allowing Spontaneous Breathing

- In comparison to an initial period of controlled ventilation for 72 hours followed by weaning, maintained SB with APRV/BIPAP is associated with significantly
  - **fewer days on a ventilator,**
  - **earlier extubation**
  - **shorter stays in the ICU**

Putensen *C.*, S. Zech , 1. Zinserling. *1998.*. Am 1 Respir Crit Care Med 157:A45

Spontaneous Breathing

The influence of (CMV), (IMV) and (BiPAP) on duration of intubation and consumption of analgesics and sedatives in adult cardiac surgery.

- **Rathgeber et al, 1997 Eur J Anaesthesiol;14(6):576–582.**
- **596 post cardiac-surgery patients.**
- **87 Patients were randomized to the 3 groups**
- **Uneven randomization**
- **CMV 123 pts, IMV group 431 pts, and biphasic CPAP group only 42 pts.**
- **Pts in the biphasic CPAP group had about 3–4 h shorter duration of intubation. Pts in CMV required greater sedation and analgesia than IMV or biphasic CPAP**
- **Conclusion : maintenance of spontaneous breathing during biphasic CPAP improved patient comfort and thus reduced pain and anxiety.**

Spontaneous Breathing

- Comparison of ventilatory and hemodynamic effects of BIPAP and S-IMV/PSV for postoperative short-term ventilation in patients after coronary artery bypass grafting.
- Kazmaier S, Rathgeber J, Buhre W, Buscher H, Busch T, Mensching K, Sonntag H
- Eur J Anaesthesiol 2000;17(10):601–610.
- 24 patients after CABG
- no difference in gas exchange or hemodynamic variables.
- PIP was lower with BIPAP than with SIMV or PSV.

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Thank You

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