Recent Trends In Ventilation Support

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New mode of ventilation, Absence of evidence is not an evidence of absence
Demonstrate how the new modes fit with the previous strategies.
Adaptive support ventilation for fast tracheal extubation after cardiac surgery: a randomized controlled study.
Clinical experience with adaptive support ventilation for fast-track cardiac surgery.
Randomized controlled trial comparing adaptive-support ventilation with pressure-regulated volume-controlled ventilation with automode in weaning patients after cardiac surgery.

Key words: ventilation, new modes , volume-controlled, pressure-regulated.

Objectives

- Evidence based strategies and guidelines

- New mode of ventilation

  Absence of evidence is not an evidence of absence

  Demonstrate how the new modes fit with the previous strategies

Evidence-based guidelines

American college of chest physicians
American Association for Respiratory Care
American college of emergency physicians
American thoracic society
Australian and New Zealand intensive care society
Society for Critical Care Medicine
European society of intensive care medicine
European respiratory society
ARDS Network

Protective Lung Strategy

• Low Tidal Volume	1 B	Grade B
• P plat	1 B	Grade B
• Best PEEP	1 C	Grade E
• Permissive Hypercarbia	1 C	Grade C
• Recruitment maneuvers	1 C	Grade E

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 — Grade A
- Non invasive ventilation

Anesthesia, Sedation and Analgesia
Neuromuscular Blockade

- **Fast track extubation** **Grade A**

- **Sedation protocol for mechanically ventilated patients with standardized subjective sedation scale target.**
  - Intermittent bolus
  - Continuous infusion
  - with daily awakening/retitration

1 B

- **Neuromuscular blockers should be avoided due to the risk of prolonged neuromuscular blockade**

1 B

Parameters Related to Ventilator

- Spontaneous Breathing
- Control Volume
- Regulate Pressure

Modes allowing Spontaneous Breathing 2

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 tissues
- broncho-constriction

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 1

- No conclusive evidence that CMV is more beneficial than a ventilation mode which supports SB

- On the other hand, benefits from modes maintaining SB include
  - improvement of pulmonary gas exchange
  - decrease in the work of breathing
  - improvement in cardiovascular effects and organ perfusion (kidney, liver and splanchnic area)

Putensen c., N. Mutz, G. Putensen-Himmer, 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 3

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

Modes allowing Spontaneous Breathing 4

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

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.

Maitaining spontaneous breathing — 3–4 h shorter duration of intubation. less sedation and analgesia

Conclusion : maintenance of spontaneous breathing during biphasic CPAP improved patient comfort and thus reduced pain and anxiety.

Rathgeber et al, 1997 Eur J Anaesthesiol;14(6):576–582.

Volume # Pressure

- V_T equal or > 12 ml unacceptable in acutely ill patient
- ARDS 2000 6 ml better than 12
- Evidence that 7 ml and 9 ml resulted in a similar reduced mortality
- Role of Pplat
- What if the patients require a spontaneous breath with

  V_T > 6ml and his Pplat< 25cmH_2O?

  If **Pplat** < 25cmH_2O and PEEP > 5 cmH_2O **V_T** up to **10** ml/kg

  If **Pplat** between 25-30 cmH_2O **V_T** of **6-8** ml/kg

  If **Pplat** > 30 cmH_2O **V_T** < **6** ml/kg

Villar and kacemareck 22004-005

Volume # Pressure

Available Modes

Volume control

- Constant flow
- Guarantees adequate MV
- V_T will not change even if lung mechanics changes
- Great studies done on V

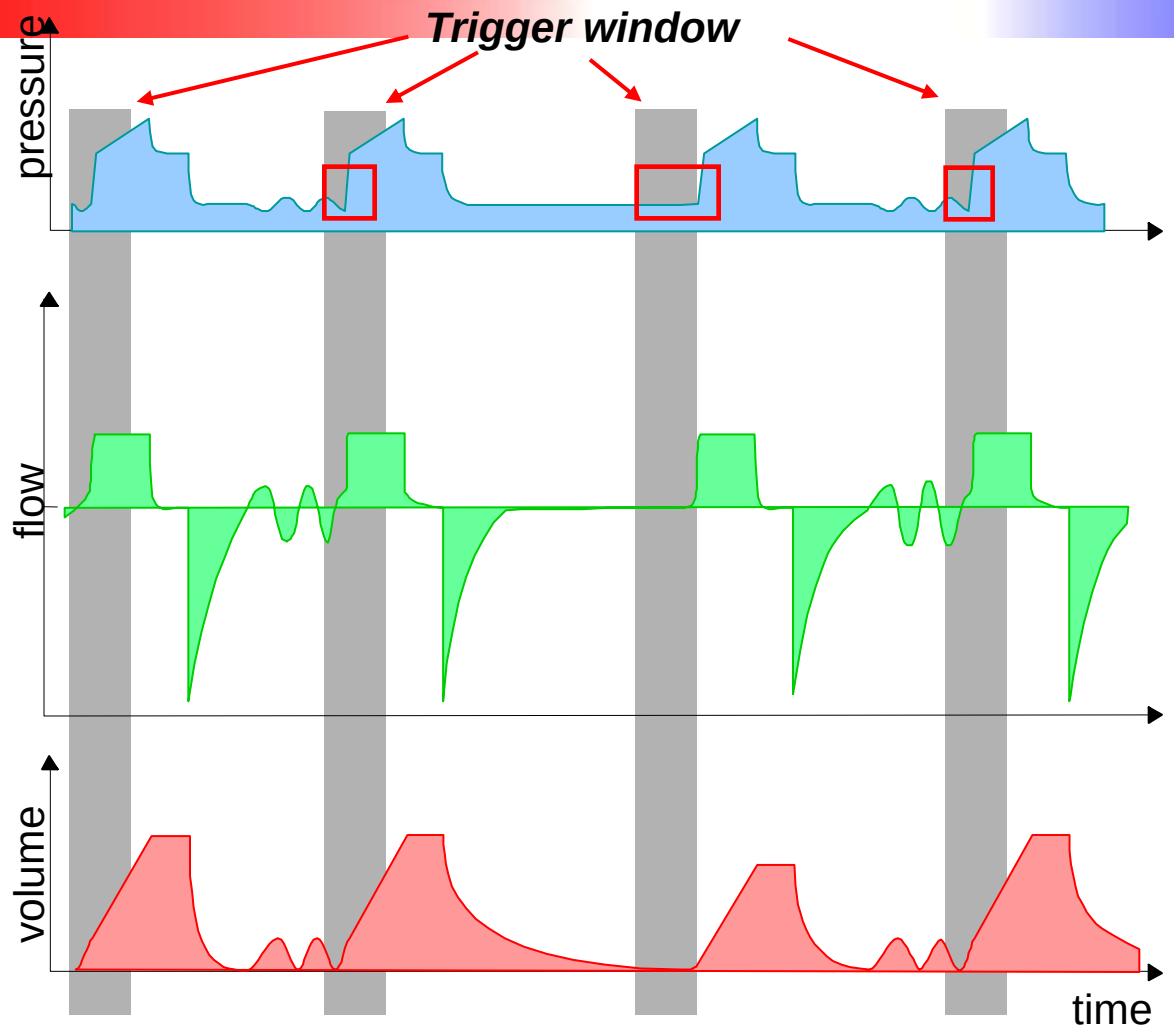
No difference on outcome

Pressure control

- Variable flow.
- Easy to use (I:E). Oxygenation
- Can compensate for minor leaks
- Higher mean airway pressure Oxygenation
- If same V_T is used in both modes P mode is associated with lower Paw
- Lower Paw means better distribution
- Protects against barotrauma

SIMV

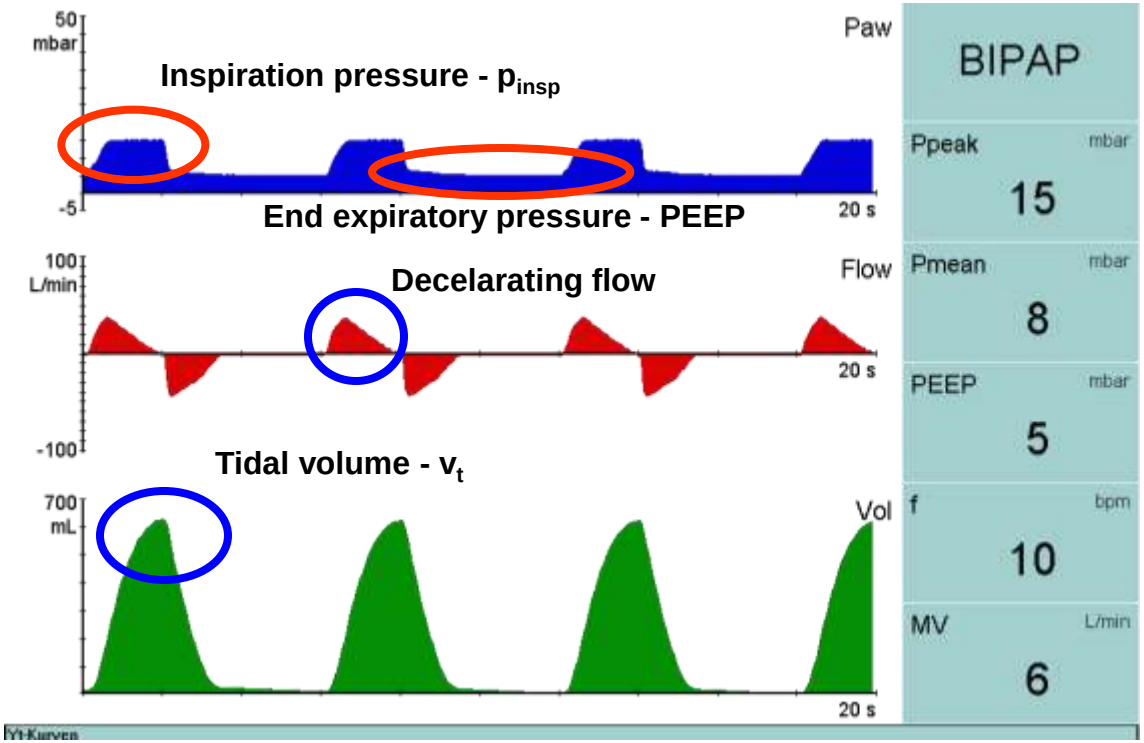
Synchronized Intermittend Mandatory Ventilation



- Volume control
- Constant flow
- User friendly
- Mandatory breath during widows
- Spontaneous in between
- High patient work
- Improved by Flow trigger PSV
- Guaranteed volume

BIPAP

Biphasic Positive Airway Pressure

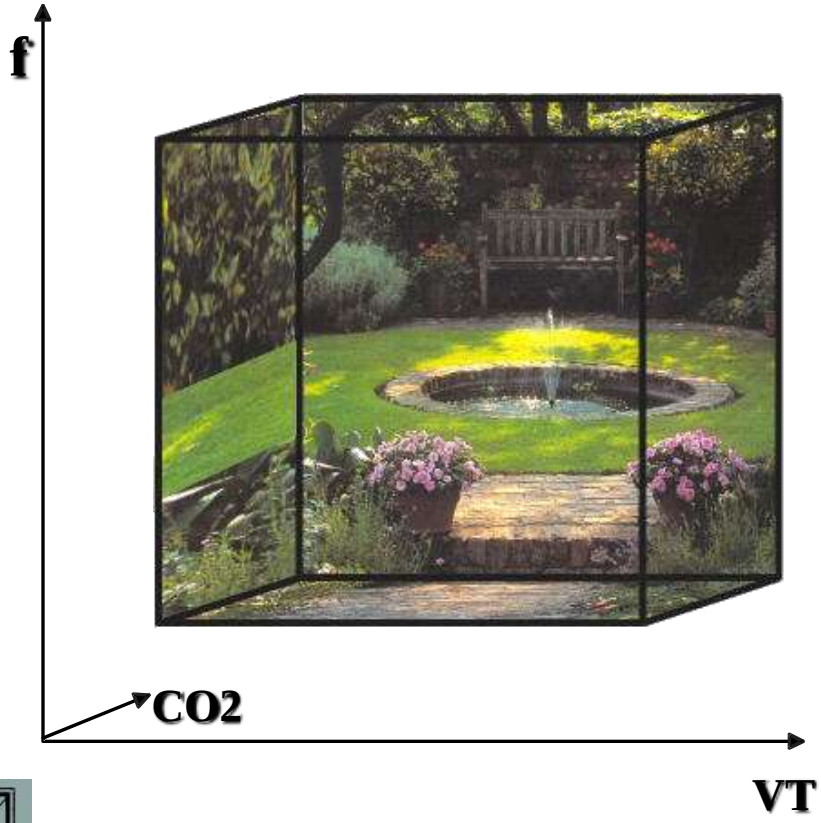


A trial to achieve a friendly global mode Window concept with all advantage of pressure

New ventilation Modes

- Dual control modes
- Work control modes
- Automated modes: Knowledge based weaning systems KBWS
- Auxiliary or adjunct modes: Auto FLow, Automatic tube compensation ATC.

Knowledge Based Weaning System KBWS
"Zone of Comfort"



Regulation based on three parameters:

- spontaneous breath rate f_{spn}
- tidal volume V_T
- $etCO_2$

  Upper and lower limit of these three parameters make the Zone of Comfort.

Pressure support variation

Not Algorithm but artificial intelligence

No control on V_T or Pplat

Work Control

Work = Volume X Pressure

- Proportional Assist Ventilation PAV
- Proportional Pressure Support PPS

Equation of Motion to calculate P_{mus}

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

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

- Adaptive support Ventilation ASV

automatically adapting inspiratory pressure and ventilator rate to changes in the patient's condition. Based on minute Ventilation (VTand F)

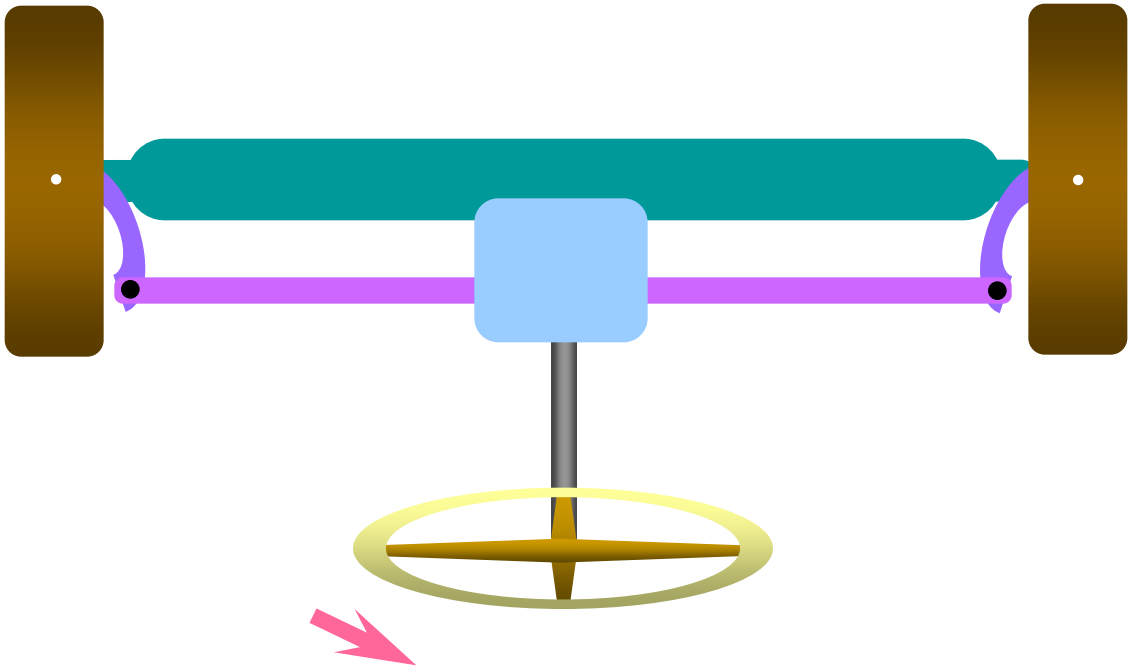
Work Control

- How are PAV and power steering similar?

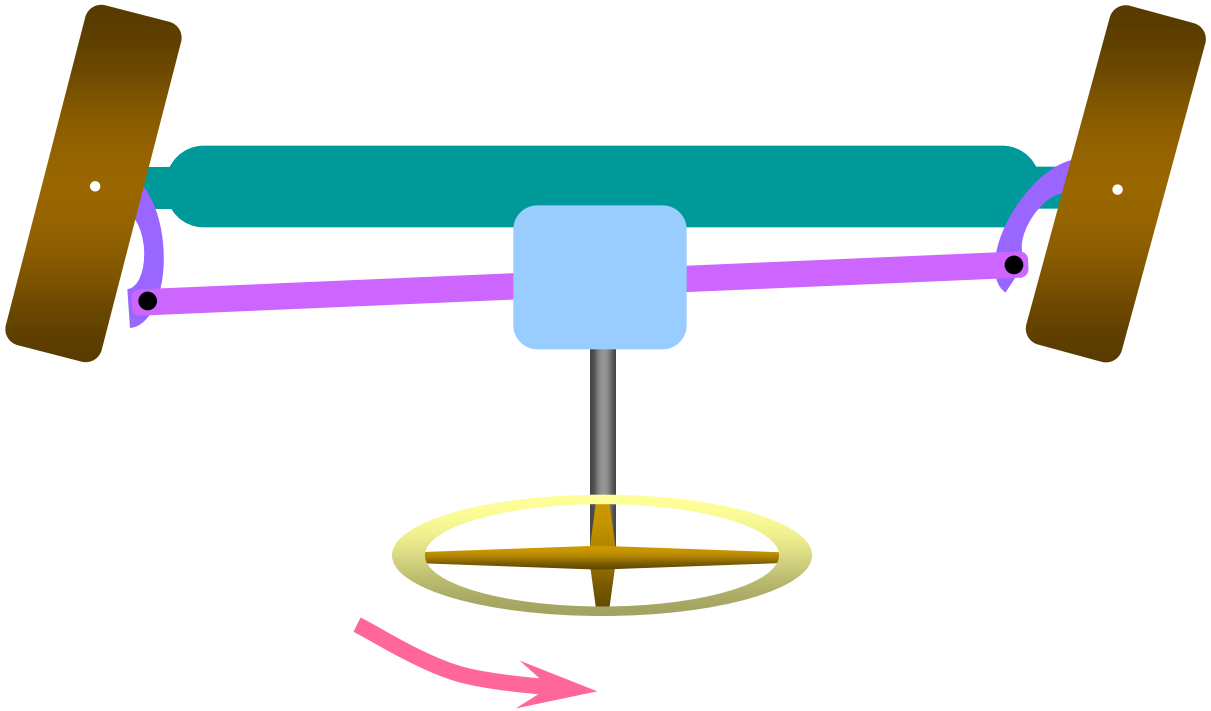
- A small vehicle may need little or no power steering
- A large vehicle may not be steerable without power steering

Power Steering Examined

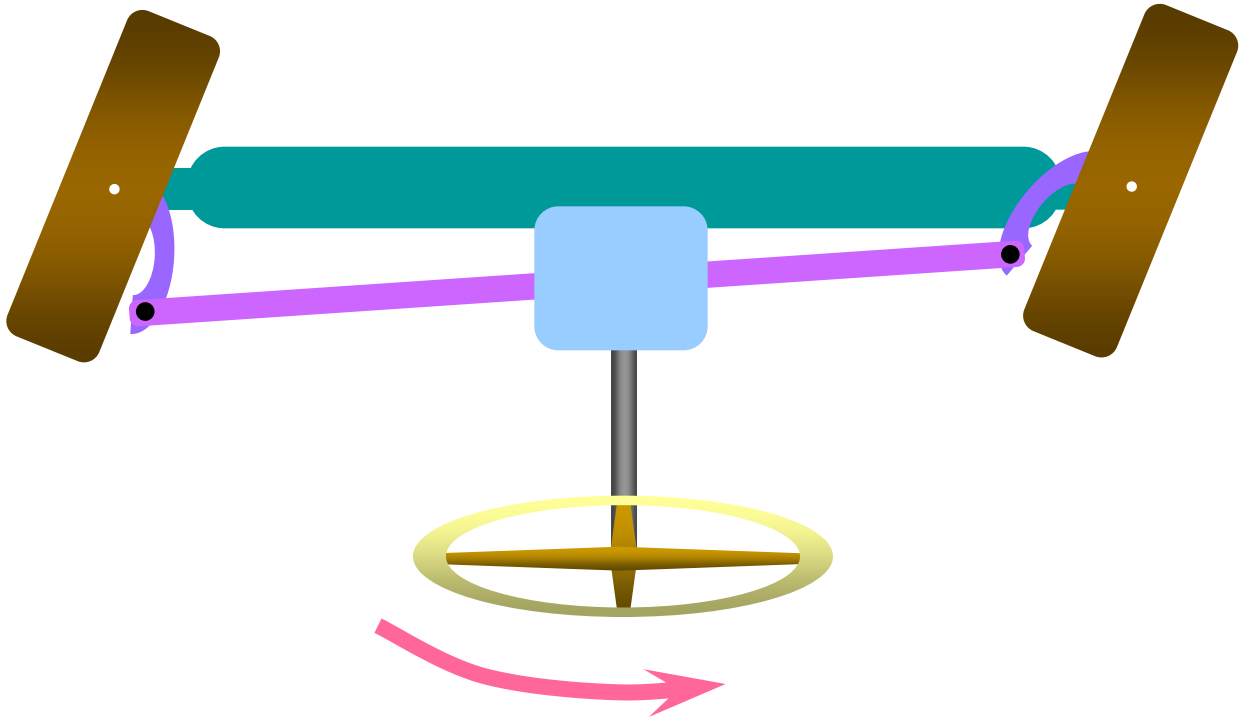
- If power steering is a good model for PAV, let's take a look .



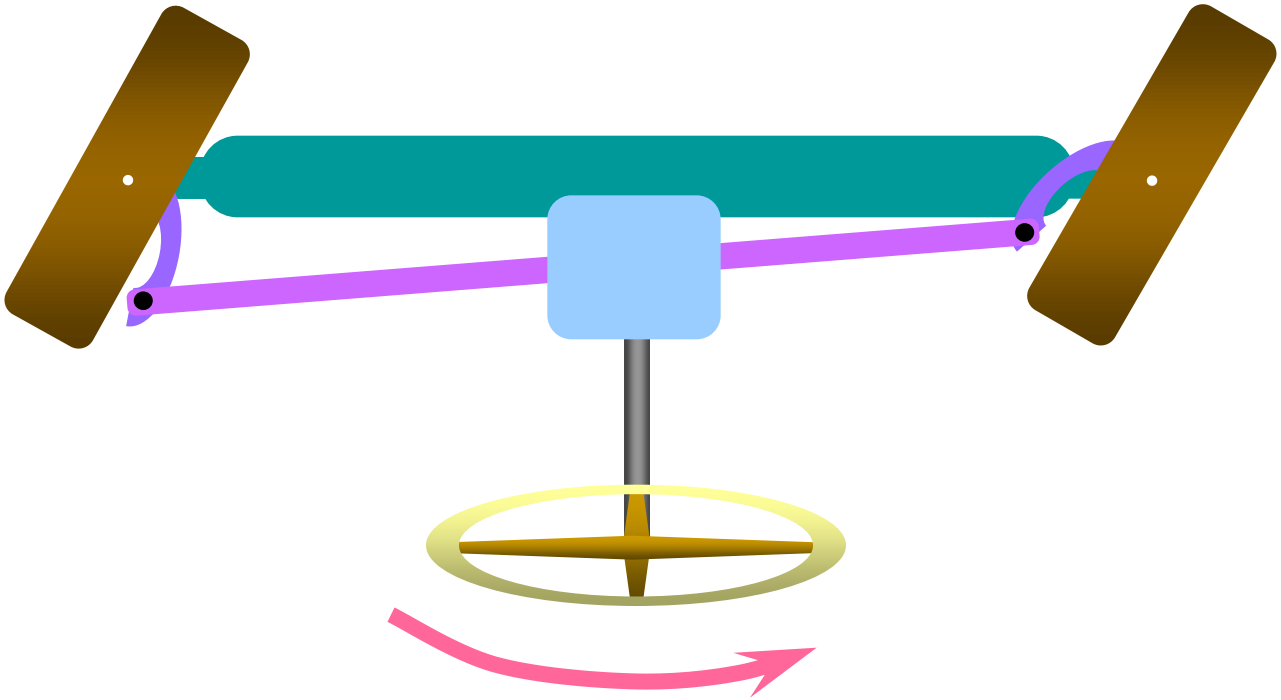
Power Steering Examined



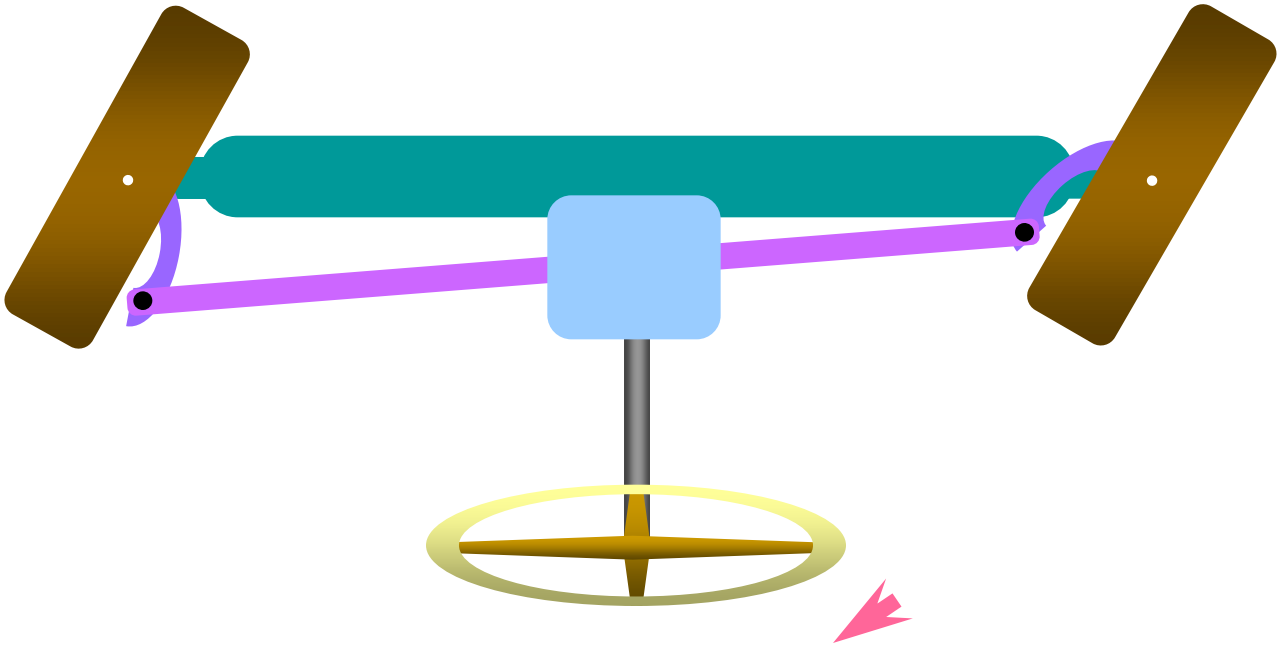
Power Steering Examined



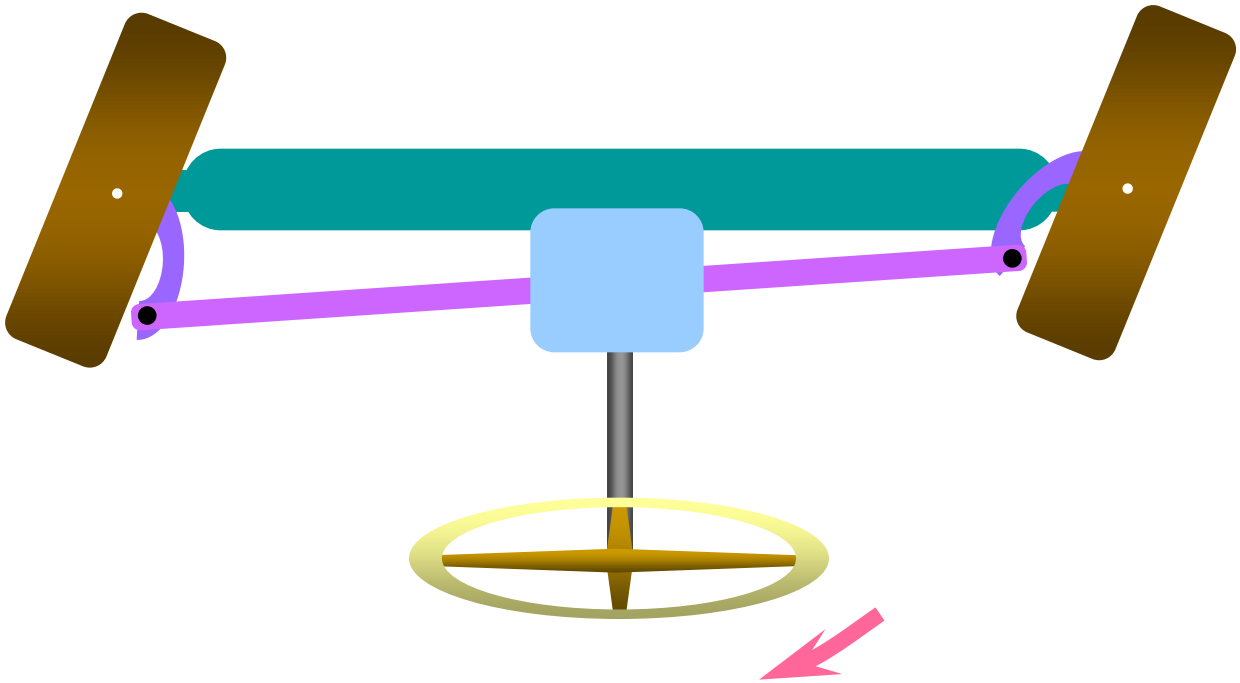
Power Steering Examined



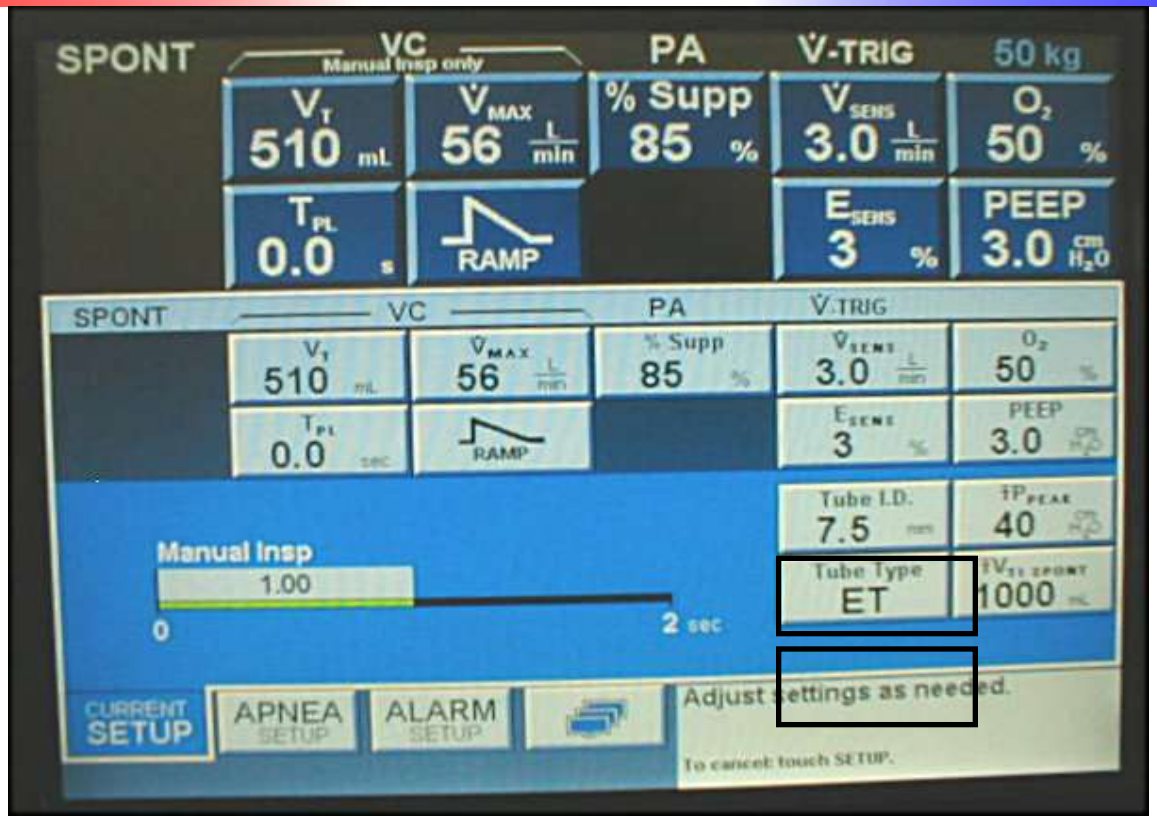
Power Steering Examined



Power Steering Examined



Work control



Work= Volume X Pressure

ASV vs SIMV/PSV

Adaptive support ventilation for fast tracheal extubation after cardiac surgery: a randomized controlled study.

36 pt group of patients being given ASV was compared with a control group (SIMV/PSV) in a randomized controlled study

Duration of tracheal intubation was shorter in group ASV than in group control 3.2 [2.5-4.6] vs. 4.1 [3.1-8.6] h

Fewer arterial blood analyses were performed in group ASV suggesting that fewer changes in the settings of the ventilator were required in this group

ASV is practicable; it may accelerate tracheal extubation and simplify ventilatory management in fast-track patients after cardiac surgery

Sulzer et al. Anesthesiology. 2001 Dec;95(6):1339-45

ASV- Safety

Clinical experience with adaptive support ventilation for fast-track cardiac surgery.

Prospective observational study

134 patients (86%) were extubated within 6 hours

No re-intubation because of respiratory failure was required.

Adaptive support ventilation was considered easy to use by both the nurses and physicians.

This ventilation mode was safe, easy to apply, and allowed rapid extubation

Cassina et al. J Cardiothorac Vasc Anesth. 2003 ;17(5):571-5

ASV vs PRVC

•Randomized controlled trial comparing adaptive-support ventilation with pressure-regulated volume-controlled ventilation with automode in weaning patients after cardiac surgery.

•Fifty patients were randomly assigned to ASV or PRVC after elective coronary artery bypass grafting

•Outcomes were duration of intubation, duration of mechanical ventilation, number of arterial blood gas samples, and manual ventilator setting changes made before extubation

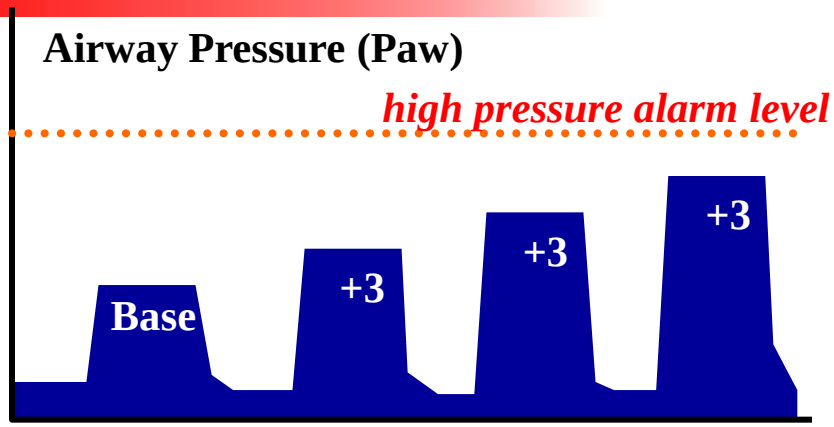
•ASV is associated with earlier extubation, without an increase in clinician intervention, when compared with PRVC in patients undergoing uncomplicated cardiac surgery

Gruber et al. Anesthesiology 2008 Jul;109(1):81-7.

Dual Control Modes

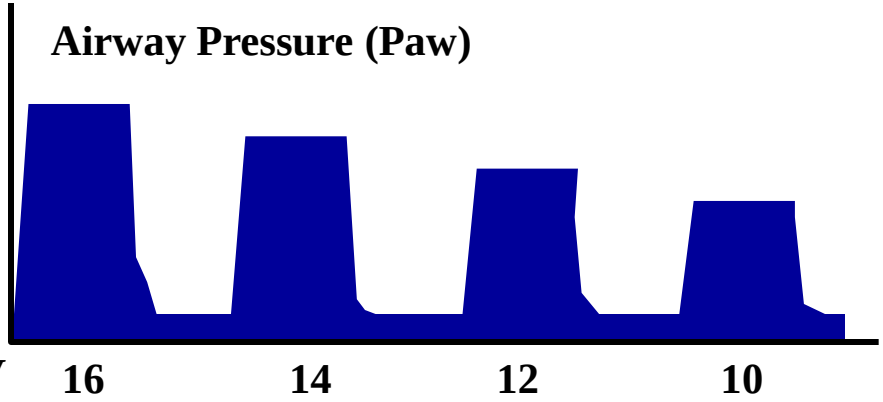
- **Dual Control**
  - Within-a-breath switches from PC to VC during the breath
    - **VAPS and pressure augmentation**
  - Breath-to-Breath
    - Pressure-Limited, Flow-Cycled Ventilation
      - **Volume support ventilation VSV** — **Siemens 300**
      - **Variable-pressure-support VPS** — **Cardiopulmonary 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**

“Breath-to-Breath” Variation



Increasing pressure to maintain volume target

Worsening Compliance



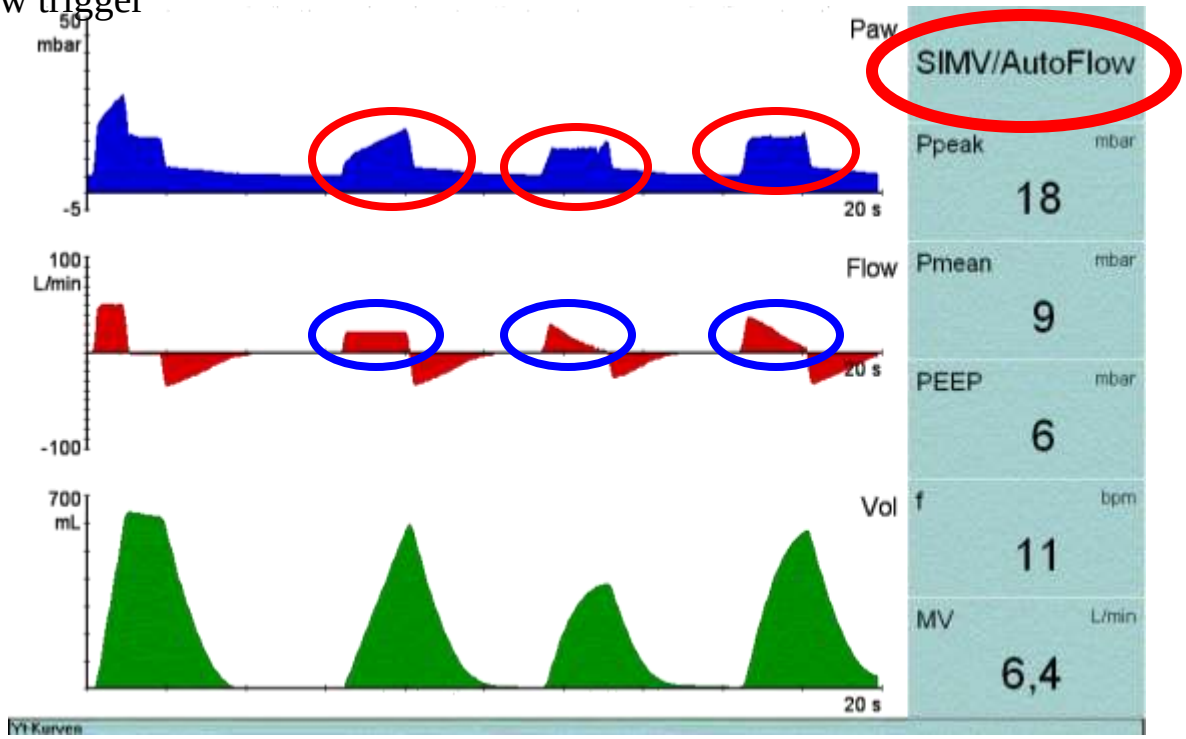
Automated, decreasing pressure

Improved Compliance

Initiation of Dual Mode

- 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



What type of lung diseases Dual mode 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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