关于机械通气模式选择

2024/11/4

- 不同呼吸模式机械通气特点
- 选择机械通气模式重要吗？
- 选择呼吸模式与疾病的关系
- 模式的发展趋势、特点
- 对选择呼吸模式的建议

机械通气模式的分类

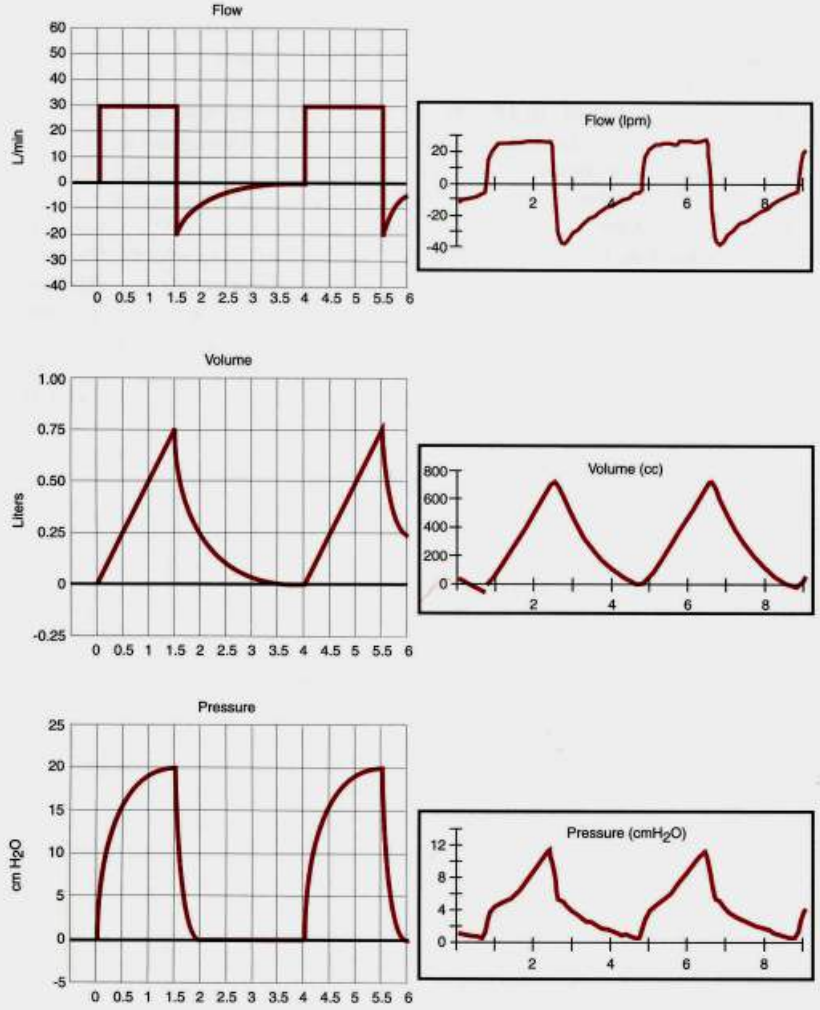
- 按送气方式分为：
- 容量模式：SIMV、A/CV
- 压力模式：BIPAP、PCV
- 闭环模式：ASV、PRVC、S C、 NAVA
- 自主模式：PSV

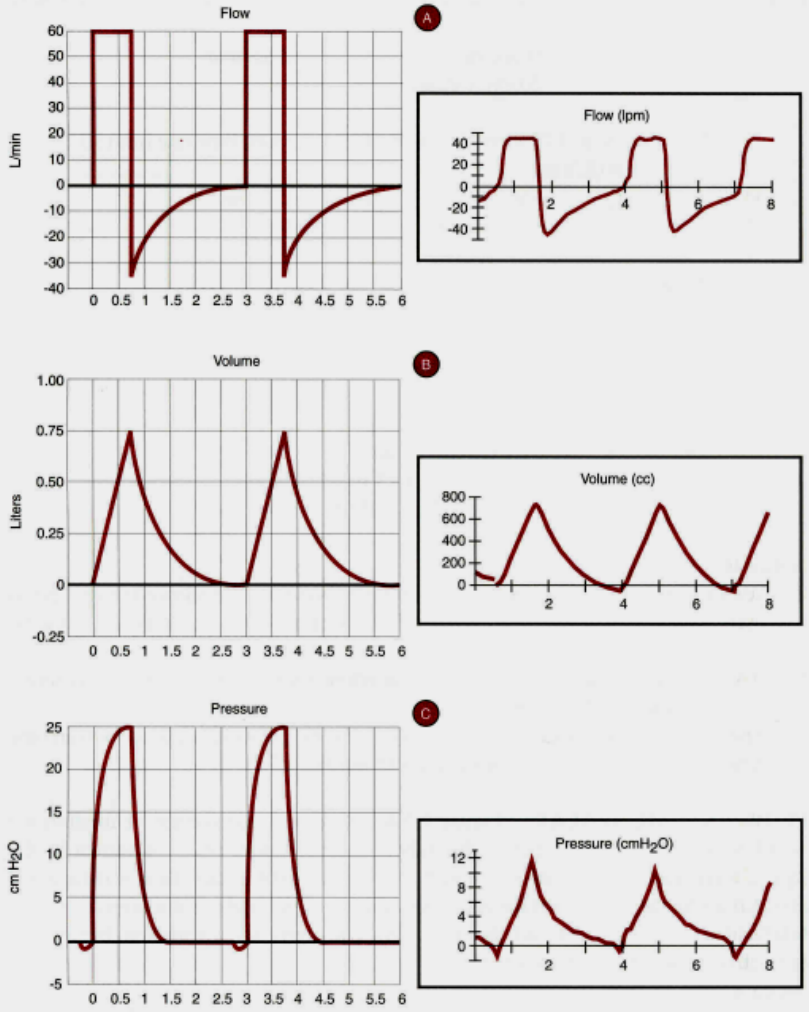
- 按人机关系分为：
- 控制通气；
- 辅助通气；
- 自主通气；

容量通气模式

容量控制模式的优点：

容量通气反应呼吸系统的机械特征

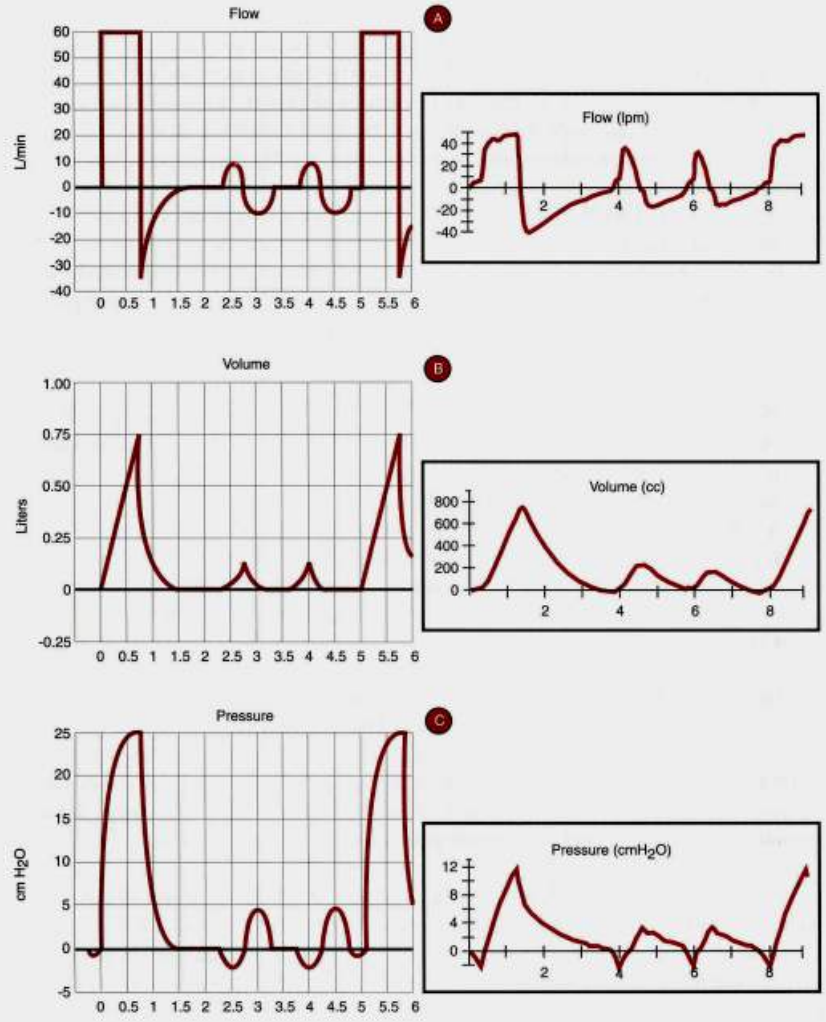


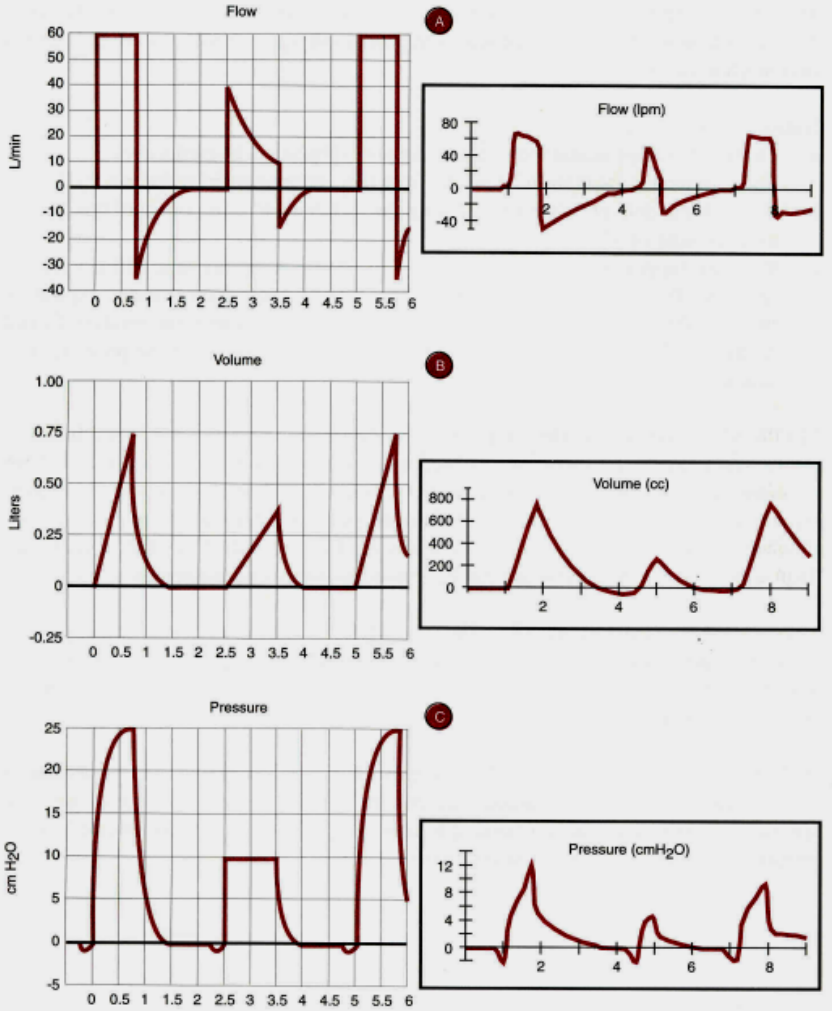


容量通气模式

容量辅助通气模式

容控模式:SIMV的临床应用



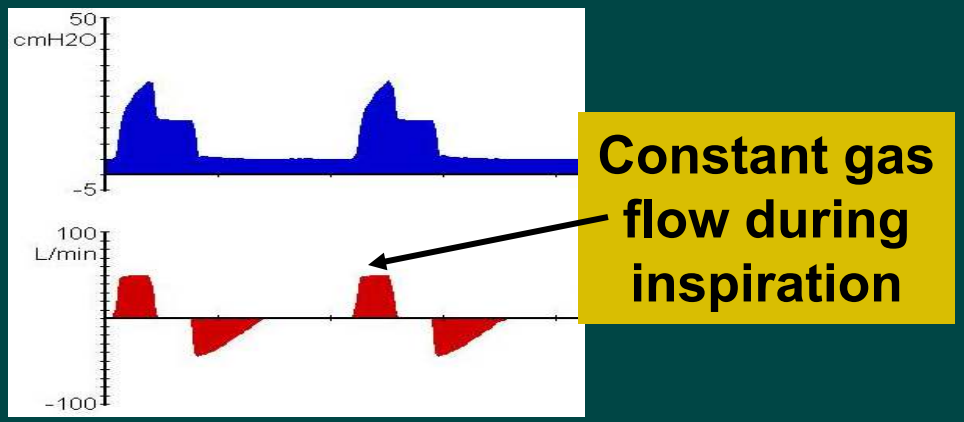


SIMV

SIMV/PSV

Problem vs Solution

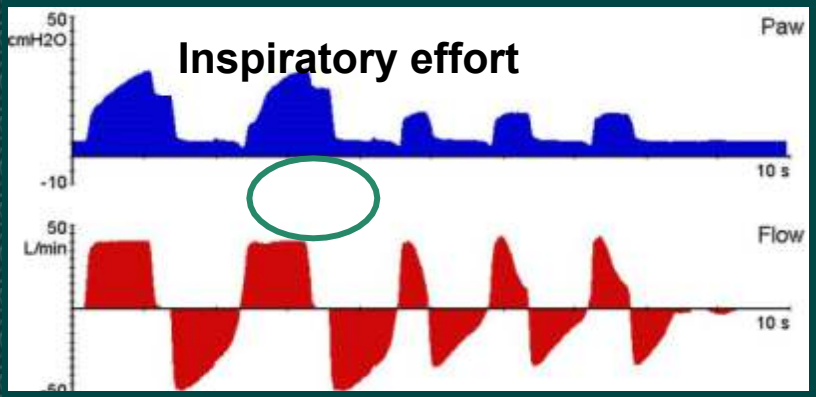
- Constant gas flow during SIMV breaths may not meet pat flow demands and rest may not be achieved.
- Flow limitation results as V_T displacement within the mandatory breath occurs through the generation of pat's pleural pressure rather than the application of airway pressure(↑ pat work, ↓ Machine work)
- Machine output or support decreases as the pat's efforts increase, inducing additional WOB.
- SIMV (volume) may not prevent fatigue or guarantee rest.

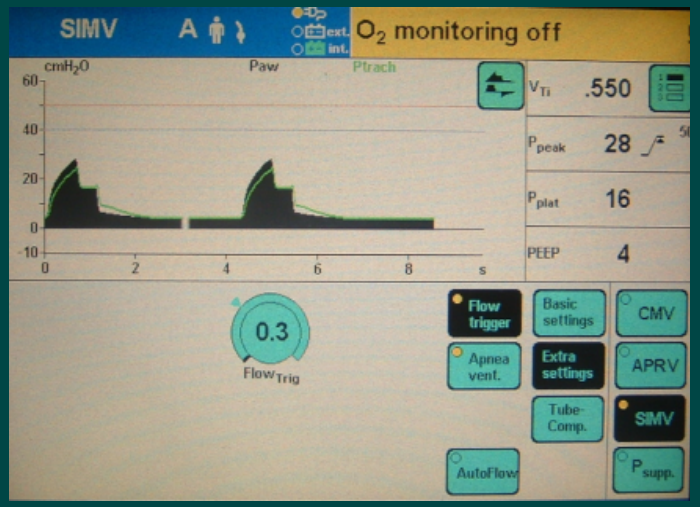


Solution

Activate AutoFlow

Problem
Increase WOB - flow trigger inappropriately set





Solution

″ Flow trigger may be set ranging from 0.3 to 15 LPM
″ The ventilator default setting is 5 LPM
″ Reducing the Flow Trigger may reduce WOB required to initiate a synchronized mandatory breath.
″ Caution: reducing the flow trigger too low may lead to autocycling

容量通气临床应用存在问题

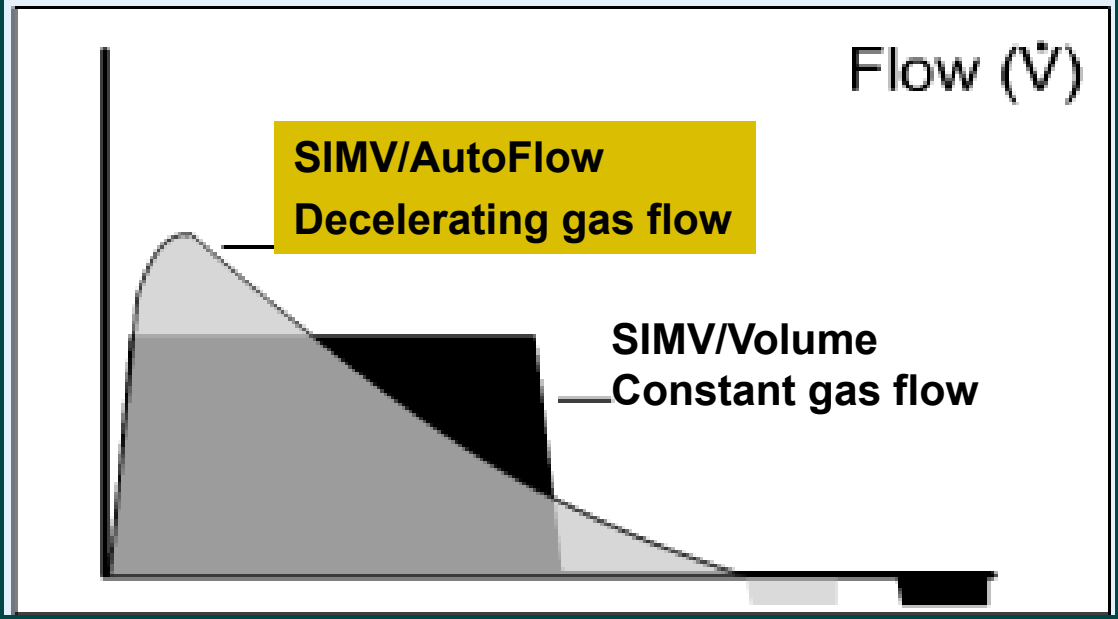
Gas Flow Patterns

Constant vs decelerating gas flow pattern
Constant gas flow may be too slow early in inspiration and too fast late in inspiration

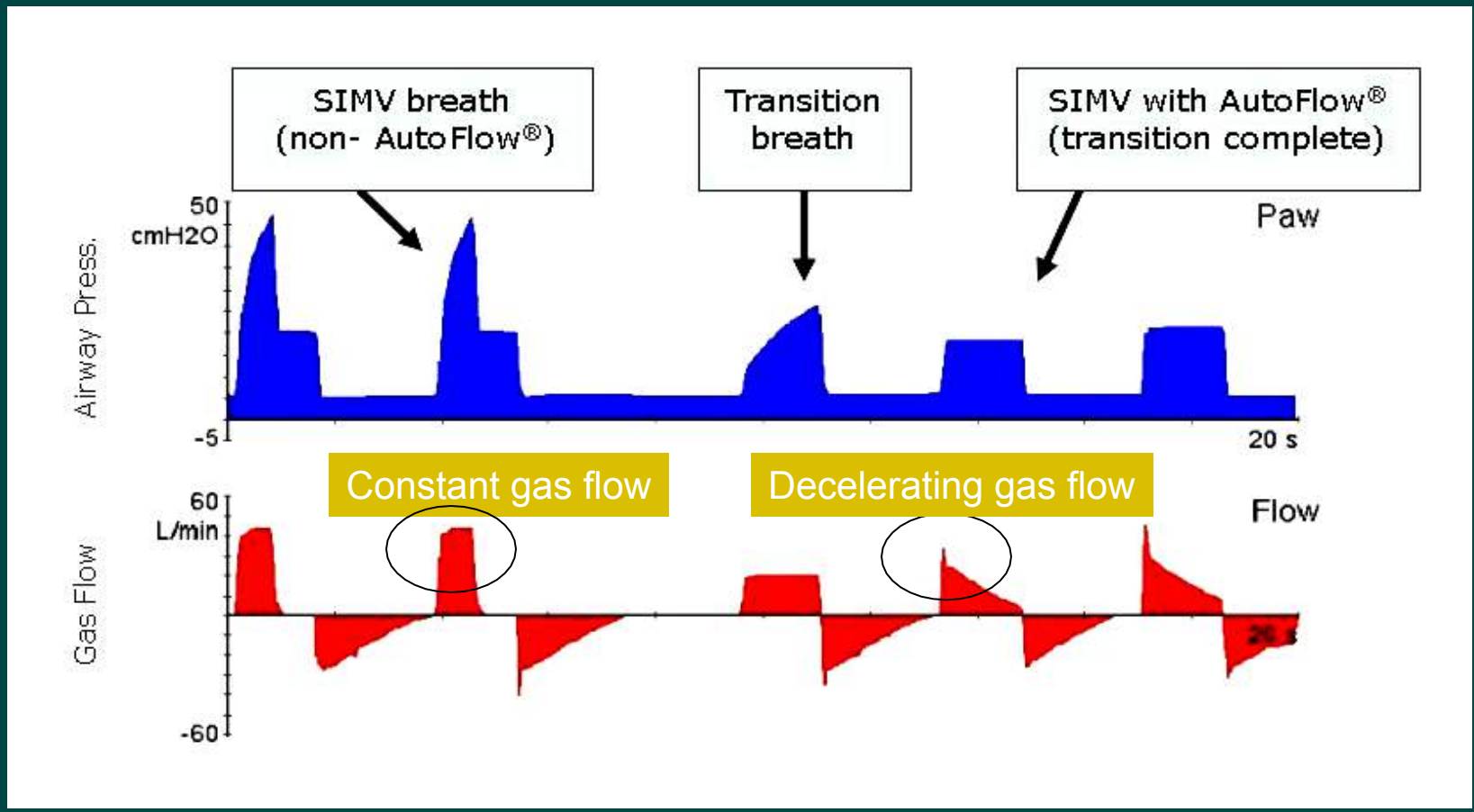
With volume-targeted modes, the gas flow is constant at set rates between 40- 80 LPM. Normal physiologic gas flow may be initially 120 LPM, for example, tapering to zero

AutoFlow

Less likely to produce flow limitation and increase WOB with increasing patient effort



Enhancing SIMV with AutoFlow



压力控制通气

- 压力控制是基于肺和管路的RC模型，通过增加补偿项简化为一阶闭环控制模型。控制的对象是流速，反馈的目标是压力。
- 实际流速的形态是以时间常数(RC)指数递减曲线，
- flow = (Pinsp-PEEP)/R * exp（-t/（R*C））
- 注：依据公式，气道阻力过高应用压控模式难以保证V_T。

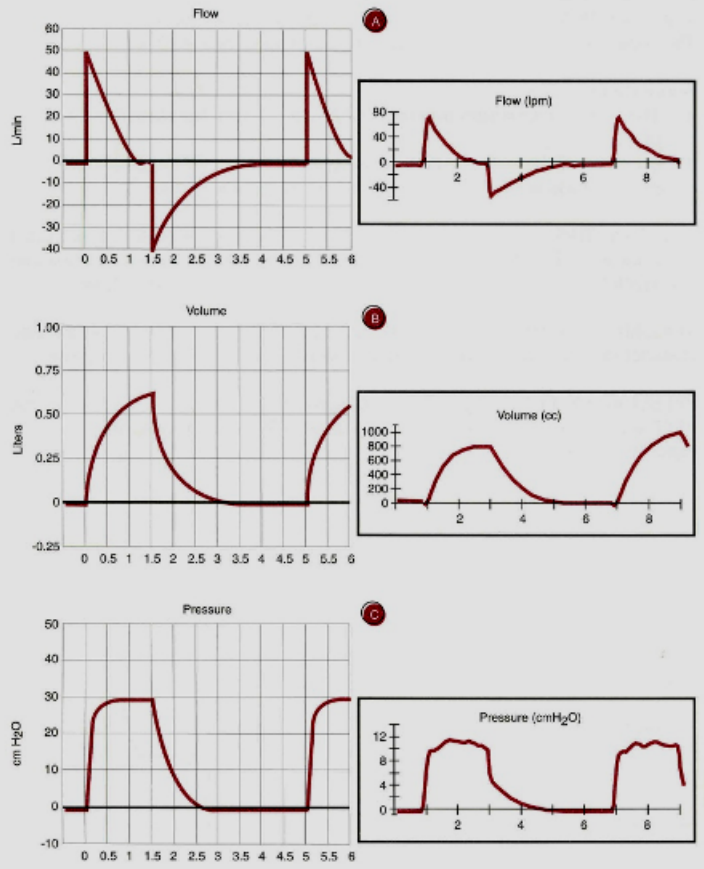


Figure 1-11A, 1-11B, and 1-11C. Pressure Control Ventilation.

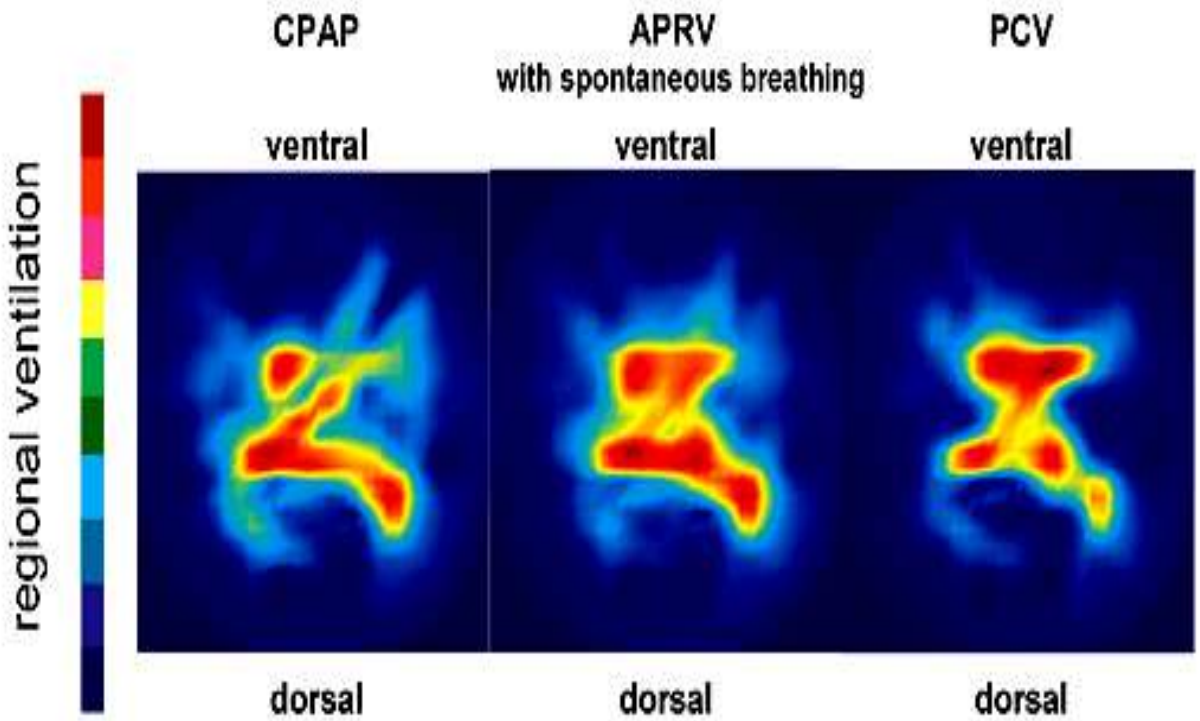
Modes of ventilation
Pressure controlled

BIPAP概念

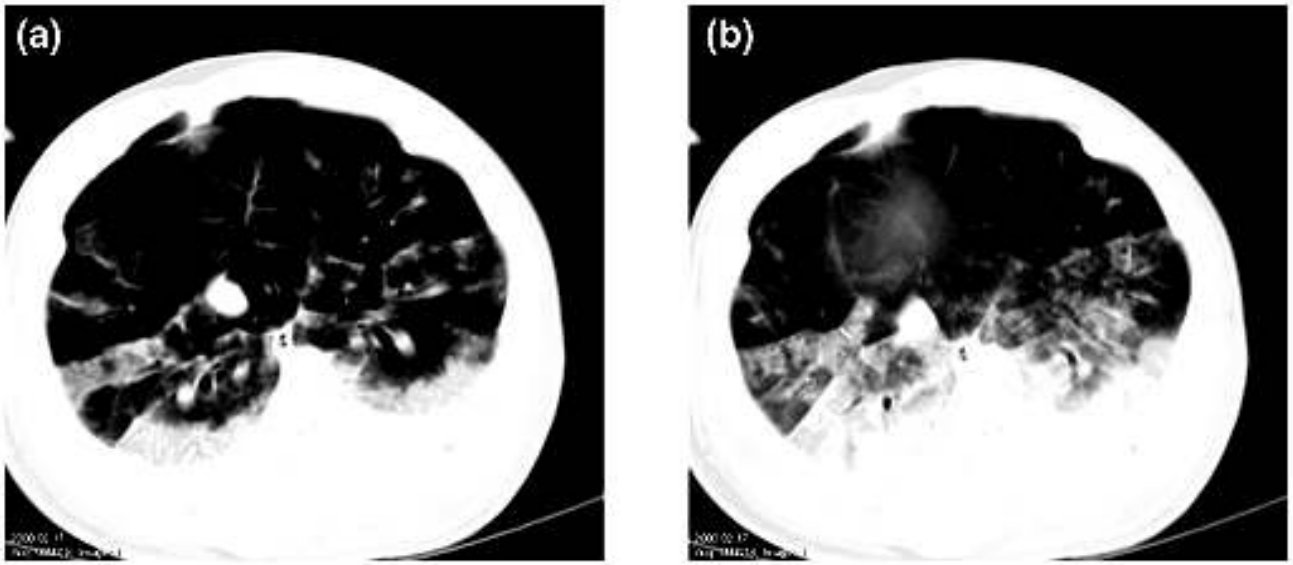
No Image

Clinical review:Biphasic positive airway pressure and airway pressure release ventilation

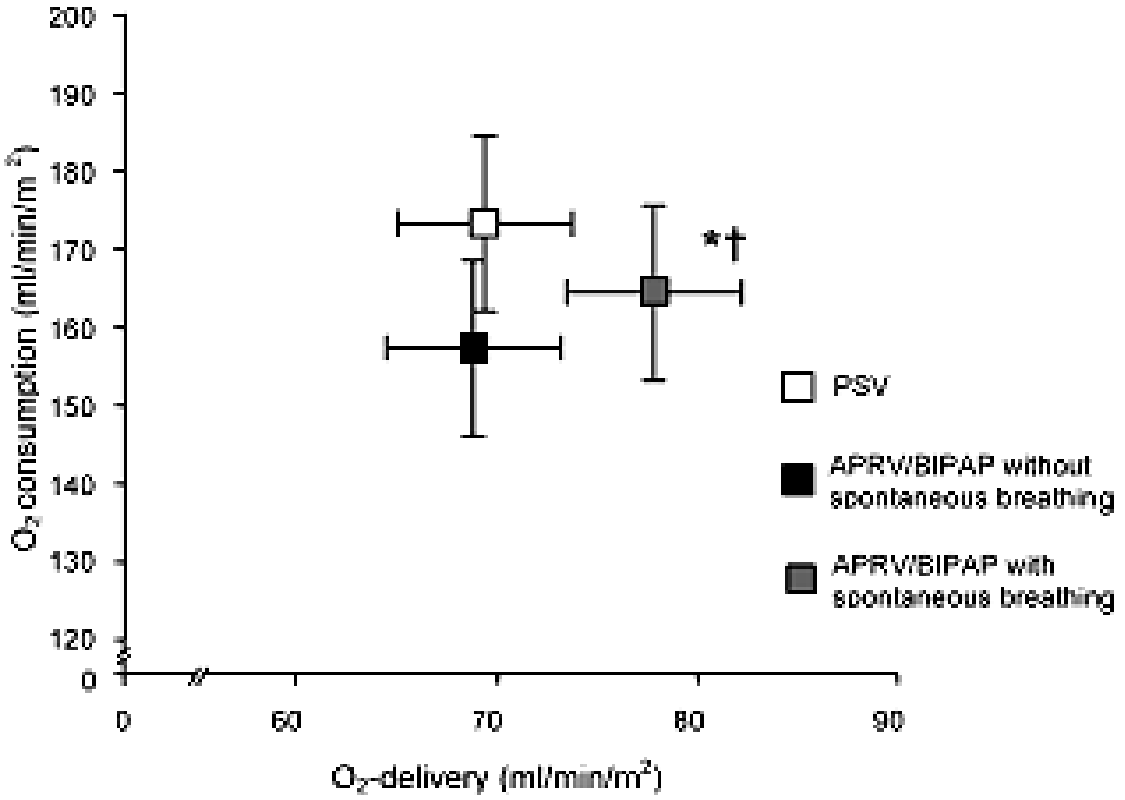
Christian Putensen and Hermann Wrigge Critical Care 2004,8:492-497



Electro-impedance tomography used to estimate regional ventilation in patients with acute respiratory distress syndrome during continuous positive airway pressure (CPAP) and airway pressure release ventilation (APRV)/biphasic positive airway pressure (BiPAP) with and without spontaneous breathing. Spontaneous breathing with CPAP is associated with better ventilation in the dependent well perfused lung regions. Spontaneous breathing with APRV/BiPAP is associated with better ventilation in the dependent well perfused lung regions and the anterior lung areas. When spontaneous breathing during APRV/BiPAP is abolished, mechanical ventilation is directed entirely to the less well perfused, nondependent anterior lung areas. PCV, pressure-controlled ventilation.



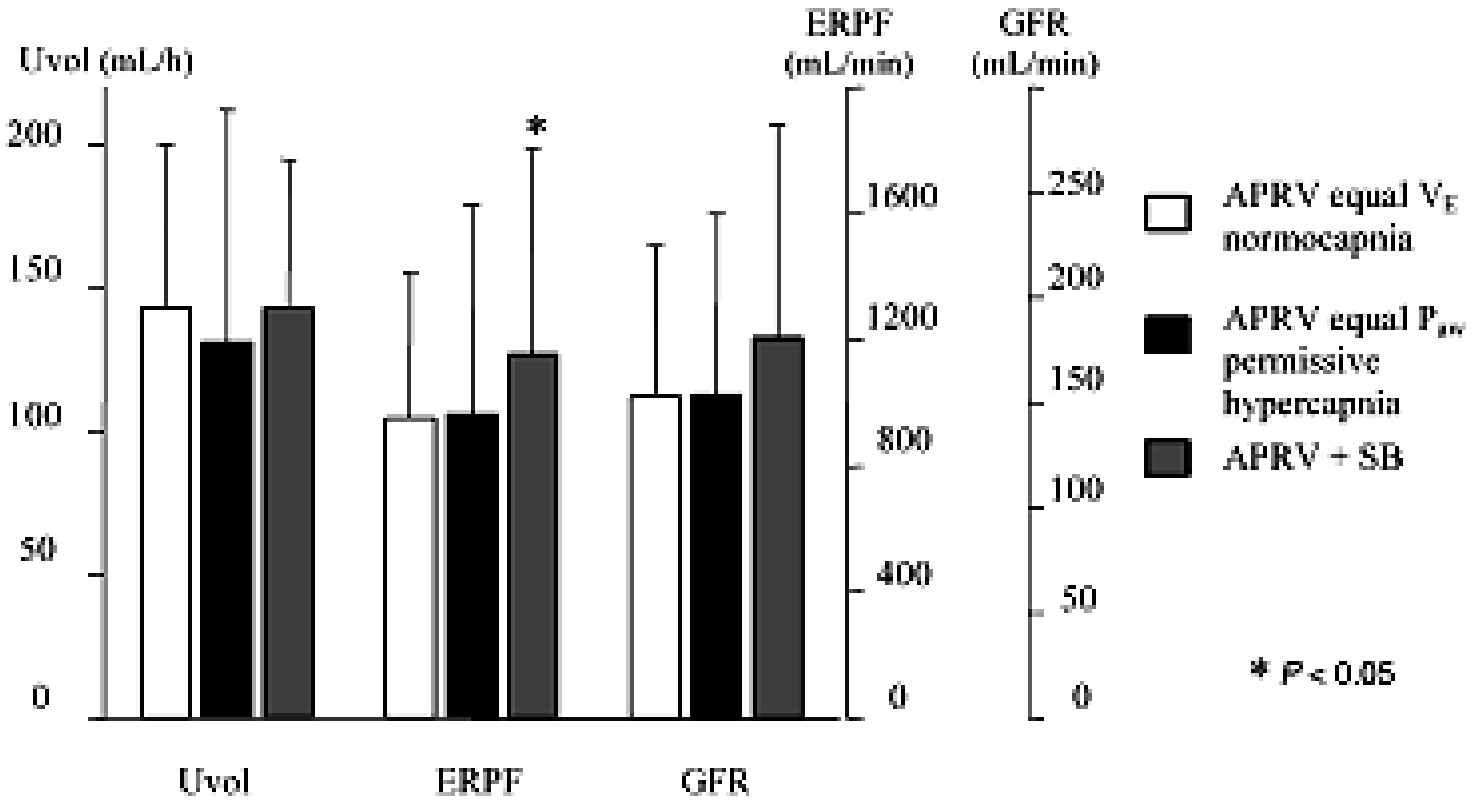
Computed tomography of a lung region above the diaphragm in a pig with oleic acid induced lung injury during airway pressure release ventilation/biphasic positive airway pressure **(a)** with and **(b)** without spontaneous breathing while maintaining airway pressure limits equal.



* $P < 0.05$ compared to APRV/BIPAP without spontaneous breathing

† $P < 0.05$ compared to PSV

Oxygen consumption plotted against oxygen delivery during airway pressure release ventilation (APRV)/biphasic positive airway pressure (BiPAP) with and without spontaneous breathing and during inspiratory assistance with pressure support ventilation (PSV). Oxygen consumption was determined by indirect calorimetry. Bars indicate standard deviation.



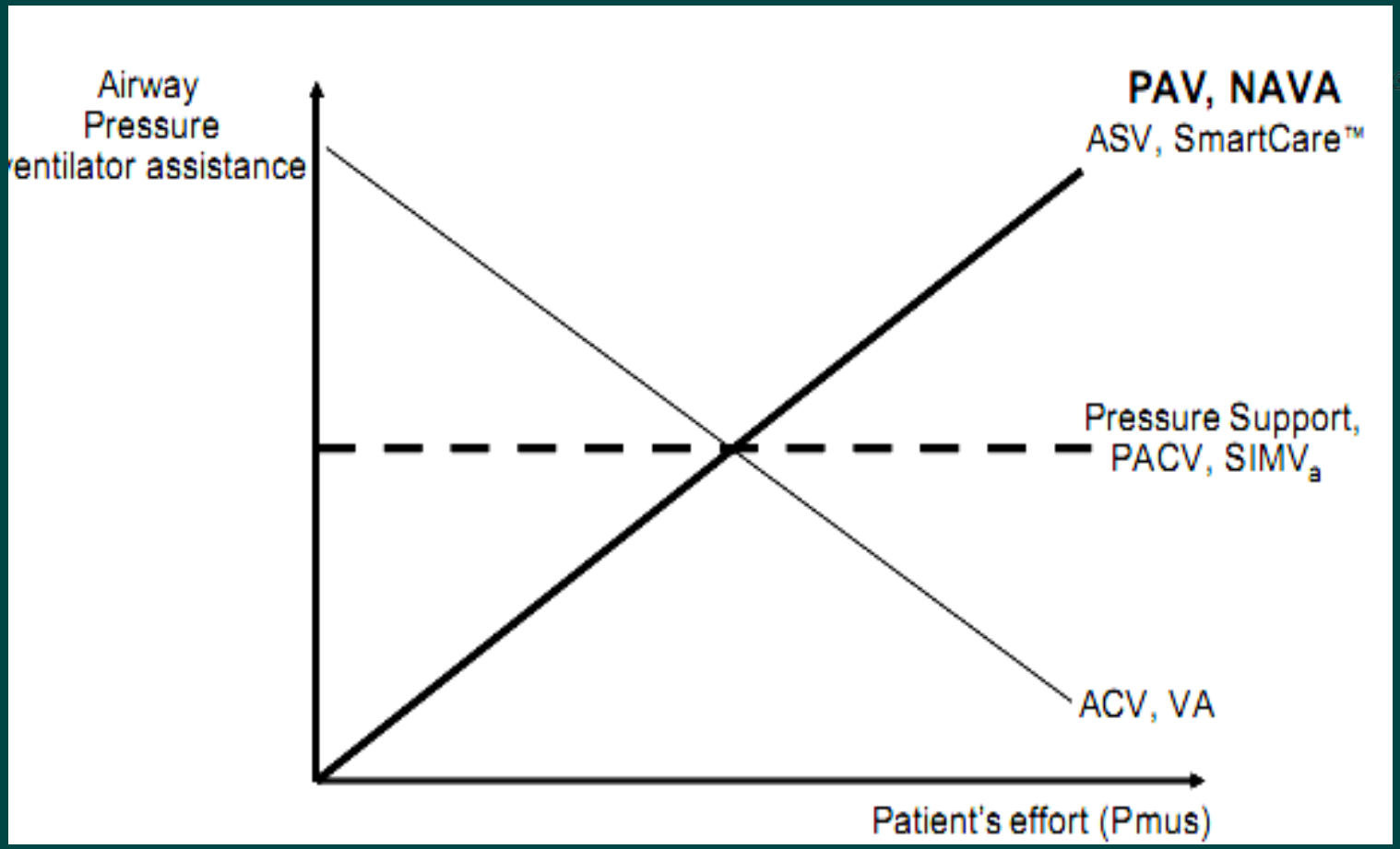
Urine volume (Uvol), effective renal plasma flow (ERPF) and glomerular filtration rate (GFR) during airway pressure release ventilation (APRV) with and without spontaneous breathing (SB). During APRV without SB, airway pressure was adjusted to produce equal minute ventilation (V_E; normocapnia) while APRV without spontaneous breathing was administered with equal airway pressure limits (P_{aw}; permissive hypercapnia). Vertical bars indicate standard deviation.

BIPAP模式

- 机械通气时自主呼吸和控制通气并存的特点。
- 保留SB的BIPAP明显改善V/Q比及DO2;
- EIT及胸CT显示保留SB的BIPAP较PCV、CPAP明显改善肺灌注;
- 保留SB的BIPAP改善组织灌注、肾血流（GFR）及尿量;
- 保留SB的BIPAP增加局部P_{TP}；相同P_{TP}时PCV与BIPAP相比BIPAP改善氧合的增加DO_2同时对循环干扰（对血流动力学影响）较PCV小。

闭环模式、辅助通气模式

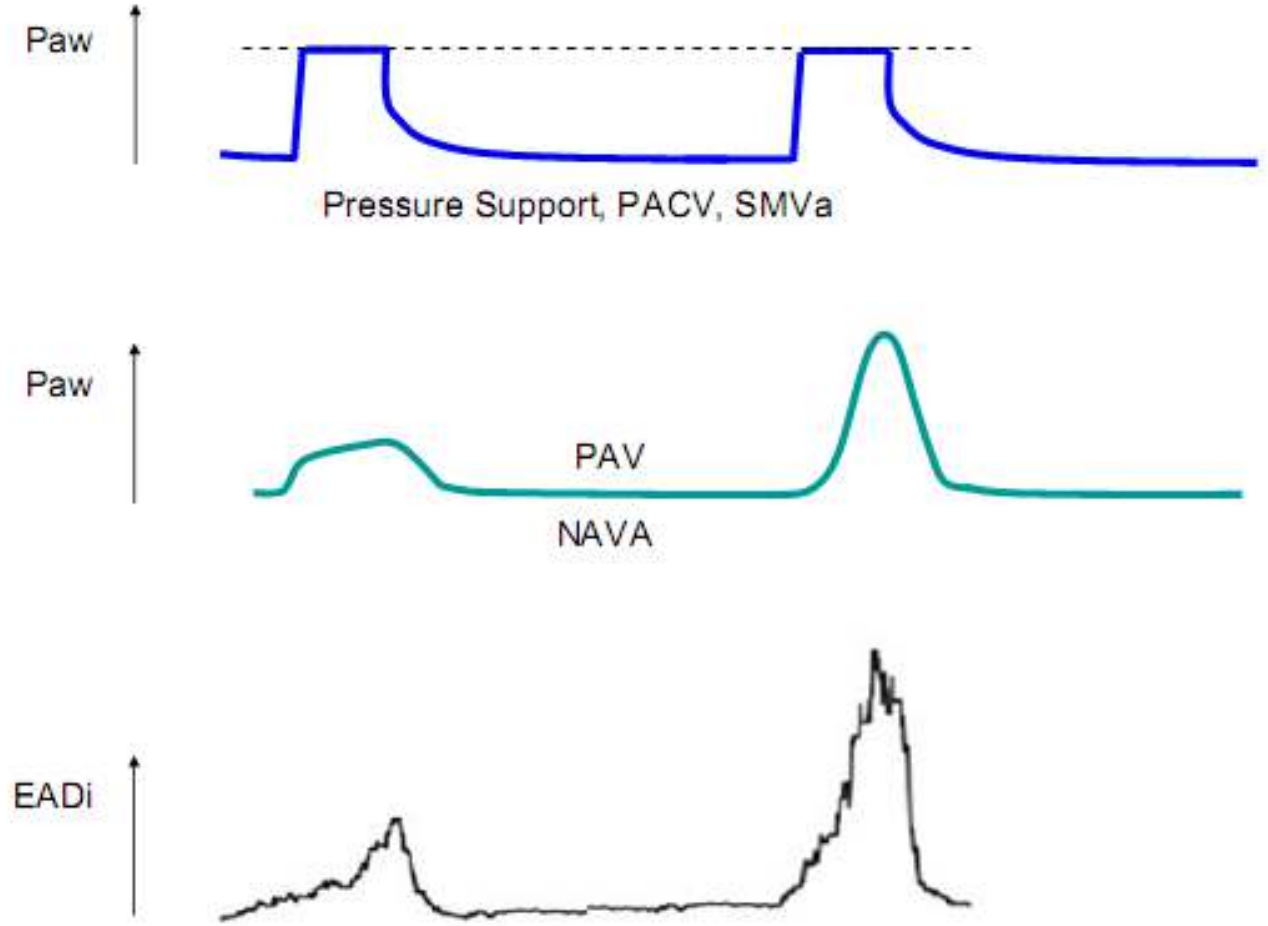
- 传统机械通气常采用恒流容量、或压力呼吸决定不同通气模式。呼吸机控制病人呼吸用力和时相变量. 正因如此，压力或容量模式能连续或间断指令通气模式。
- 容控:由医生设定峰流速及恒定的V_T，气道压力变化受病人呼吸用力、呼吸系统顺应性、阻力的影响峰压、V_T。



图传统的压力辅助模式:在不同模式病人吸气用力期间气道压力输入，当病人触发呼吸机输入设定的压力水平，容量辅助模式气道压降低。PAV通气是辅助压力与病人呼吸用力成比例。类似通气模式是ASV、Smart Care.ASV反应时间是几个周期;SC是几分钟内.

ACV辅助控制通气、PACV压力辅助控制通气、VA容量辅助。

F. Lellouche, L. Brochard / Best Practice & Research Clinical Anaesthesiology 23 (2009) 81–93



图描记两个连续周期在不同吸气努力期间，输入压力支持和其他传统的压力模式与两个比例支持模式的压力水平。曲线代表了不同病人的呼吸用力的两个连续的呼吸周期。在传统压力辅助模式气道压稳定。在PAV和NAVA与病人努力成比例。NAVA直接与病人EADI信号相连;这个模式理论优点是有更好的人机同步。

- 容控保证V_T、VA；尤其在Crs改变和高碳酸血症及肺保护方面有帮助。然而容控固定流速能导致流速不同步或过度呼吸作功。
- 压控限制肺最大气道压，减轻呼吸作功。有可变流速和流速波形的优点。

因此，压控可降低VILI、减低呼吸作功；在主动呼吸可提高人机同步。但是，在压控期间V_T可变，可引起过度通气或低通气。