ABC… XYZ: Why So Many "Modes" of Ventilation?

Oregon Society for Respiratory Care

Eugene, Oregon

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Presented by:
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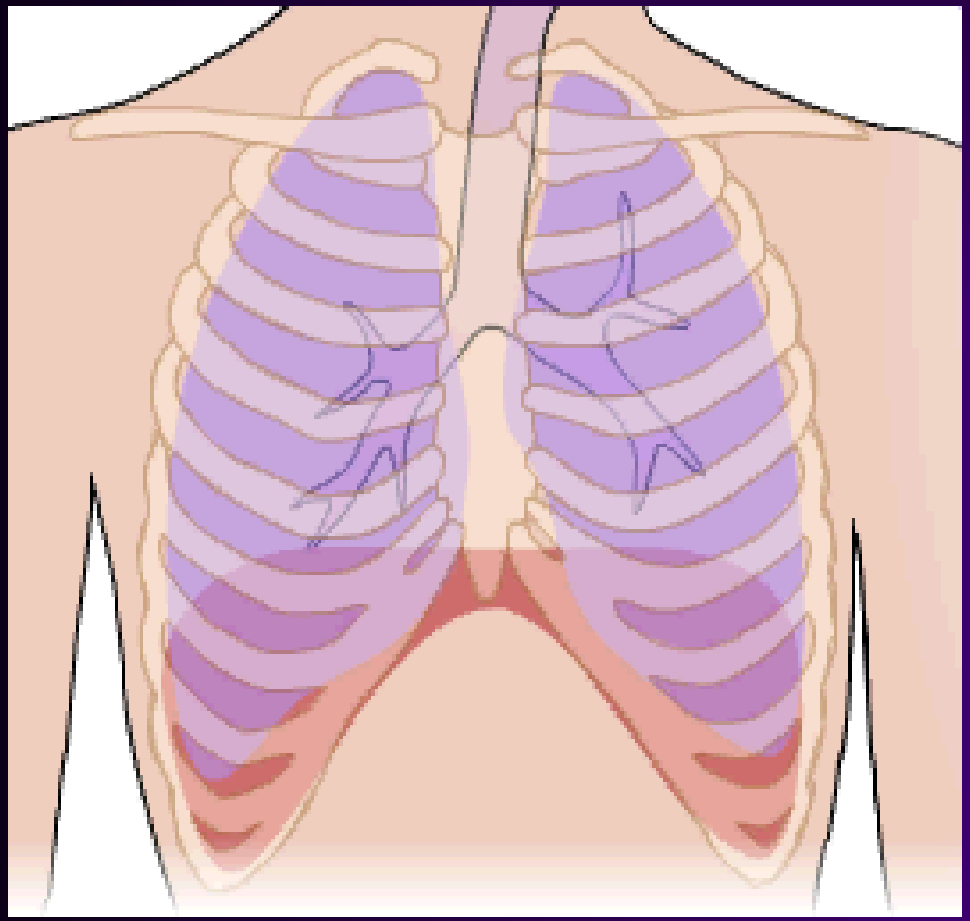
Dräger medical

“Modes” of Ventilation

1: spontaneous breathing

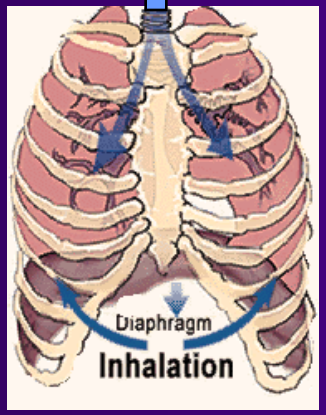


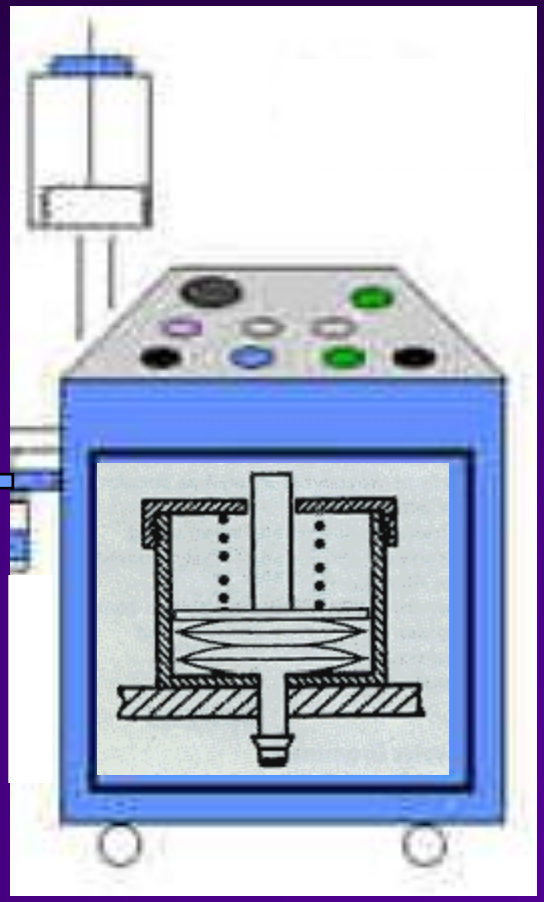
Negative intrathoracic pressure aids in venous return

“Modes” of Ventilation

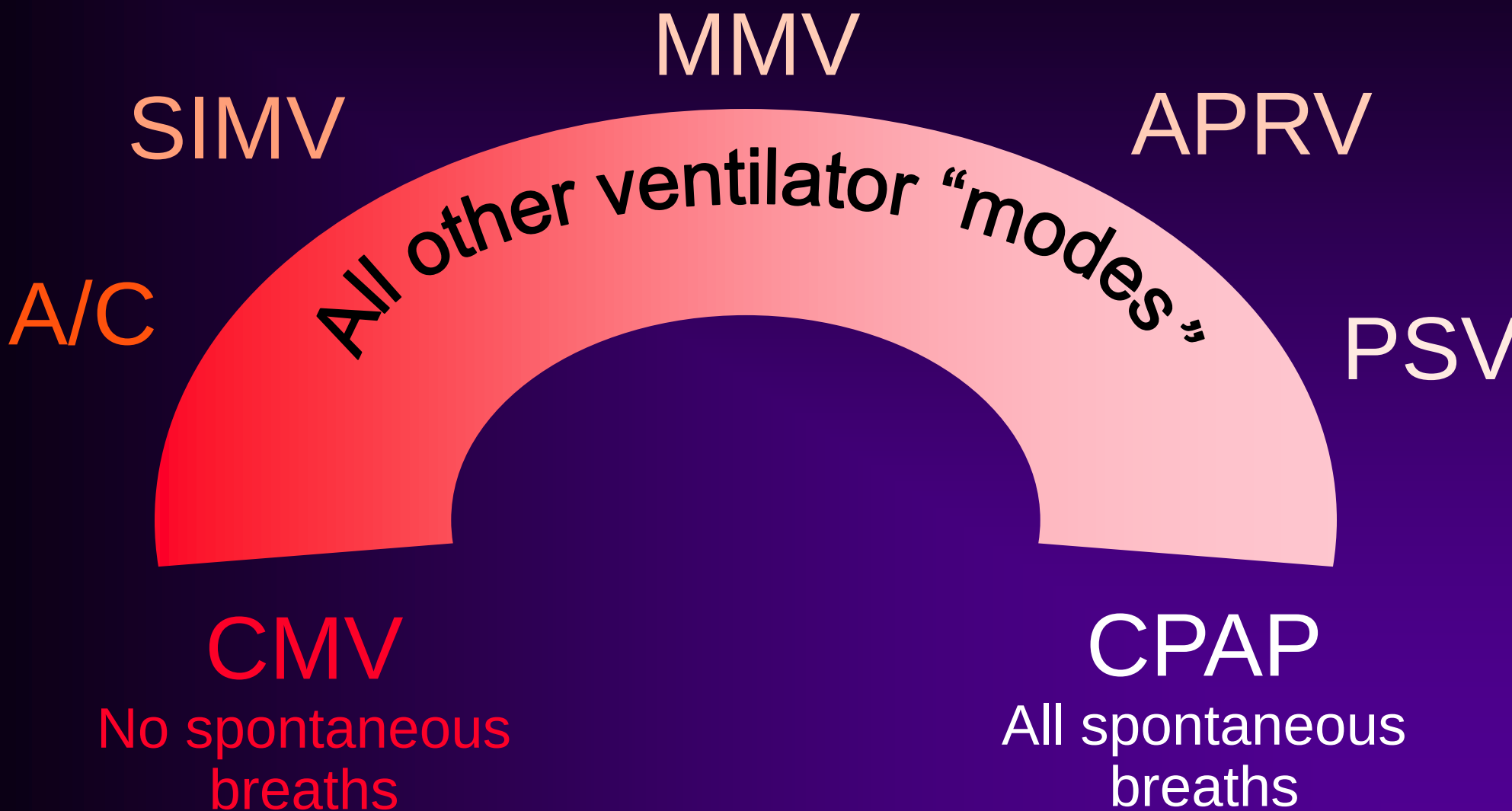
2: mechanical PPV

Positive intrathoracic pressure decreases pulmonary blood flow & impedes cardiac function

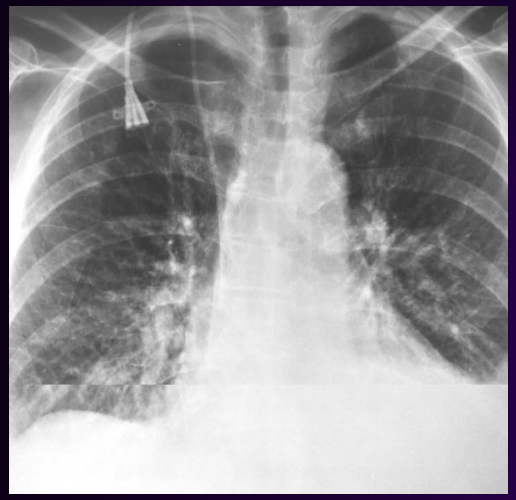




The spectrum of patient- ventilator interaction

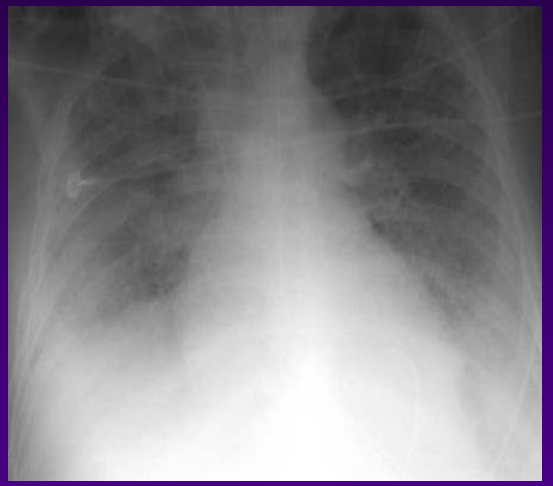


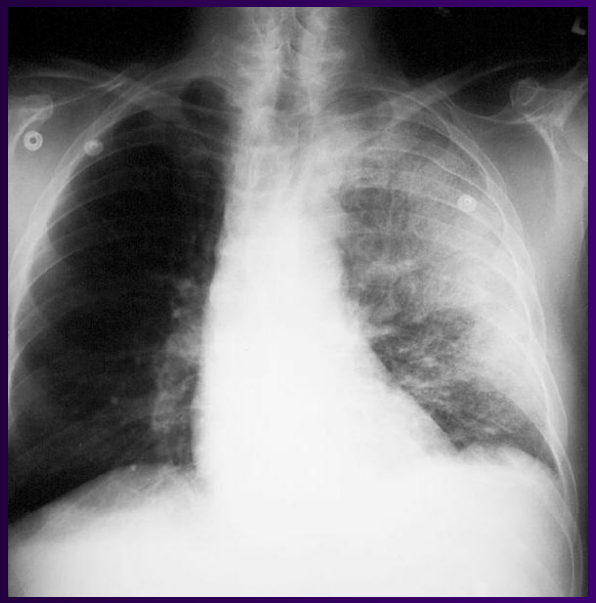
Restrictive Lung Disease



Pulmonary Fibrosis

ARDS



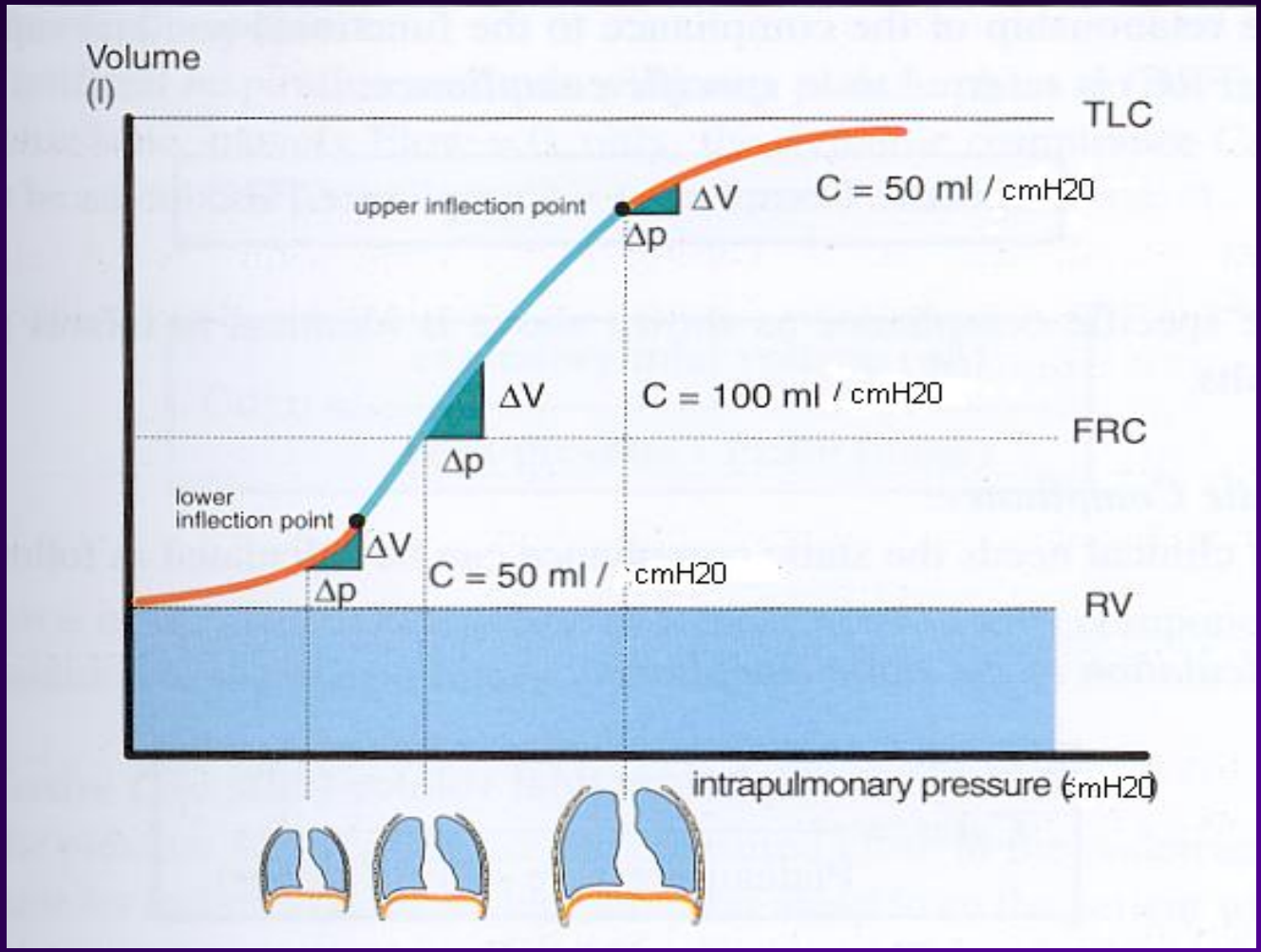


Pneumonia

Decreased lung volume results in increased work of breathing

Livin' low on the curve:

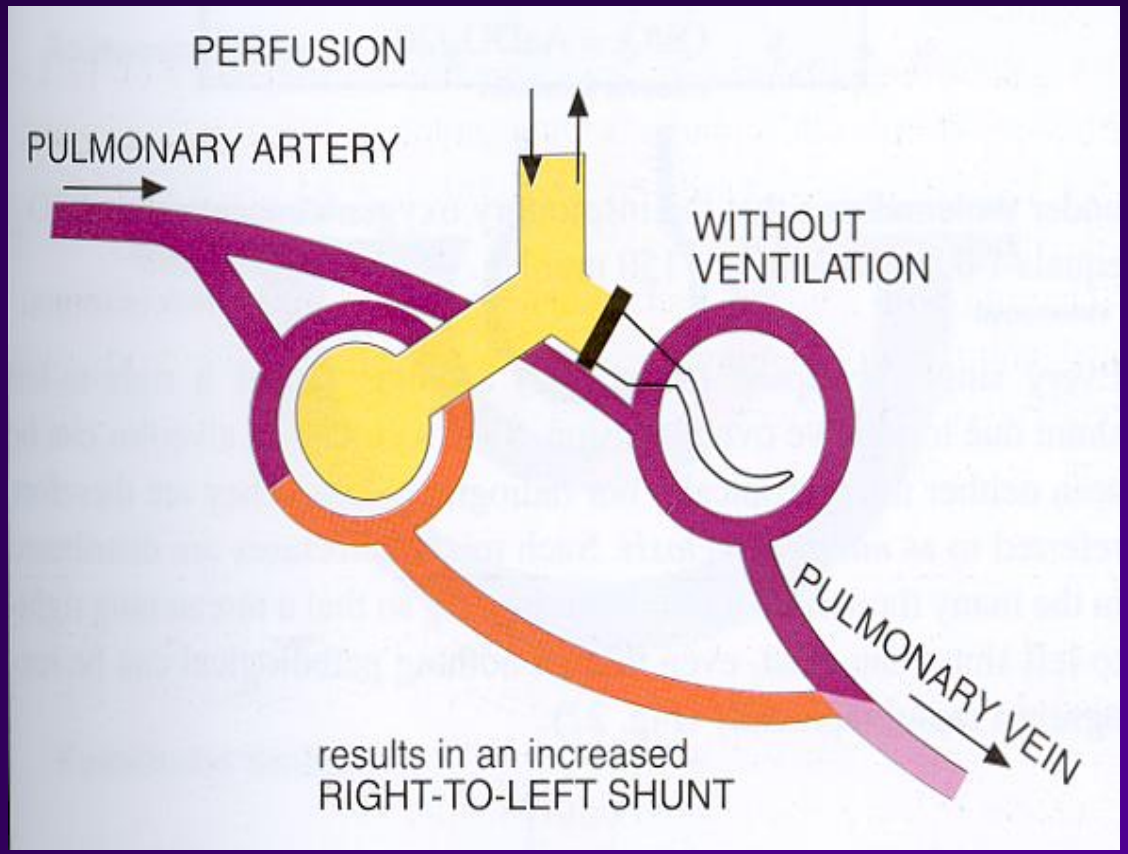
- **WOB high (less V for the P)**
- **low V_T**
- **high rate to maintain Ve**
- **increased V_D/ V_T**



Decreased lung volume results in right to left shunting

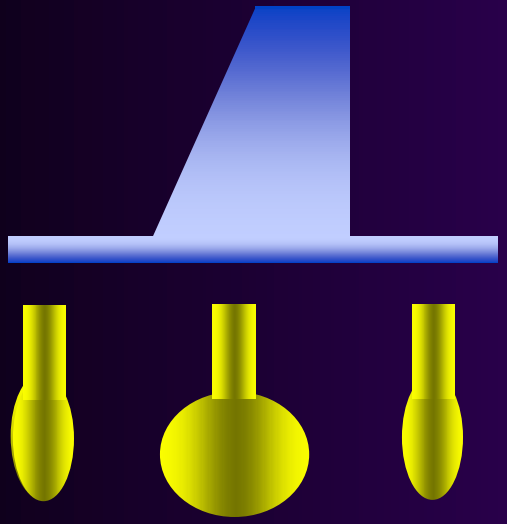
Low V/Q

- **hypoxemia**
- **unresponsive to increased FiO2 if Q_S/Q_T > .30**
- **Tx: PPV + PEEP**



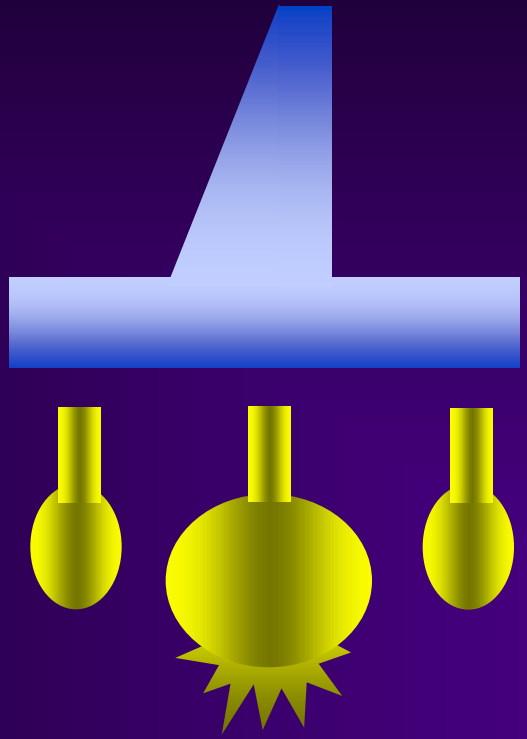
Conventional Ventilation in ARDS/ ALI

Low PEEP - Normal V_T



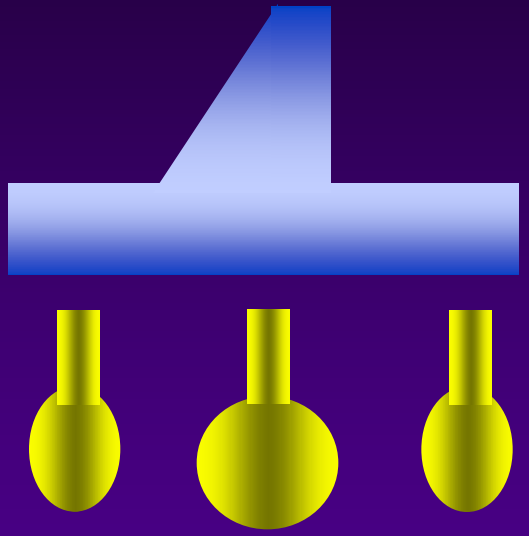
- de- recruitment
- shear force injury

High PEEP - Normal V_T



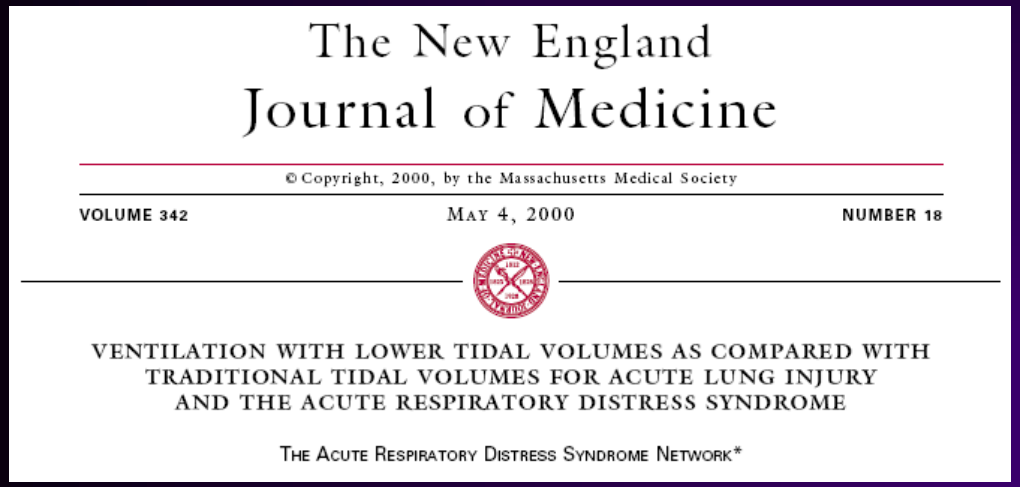
- overdistention
- volutrauma

High PEEP - Low V_T



- hypercapnia
- heavy sedation

Results of the ARDSnet low tidal volume study



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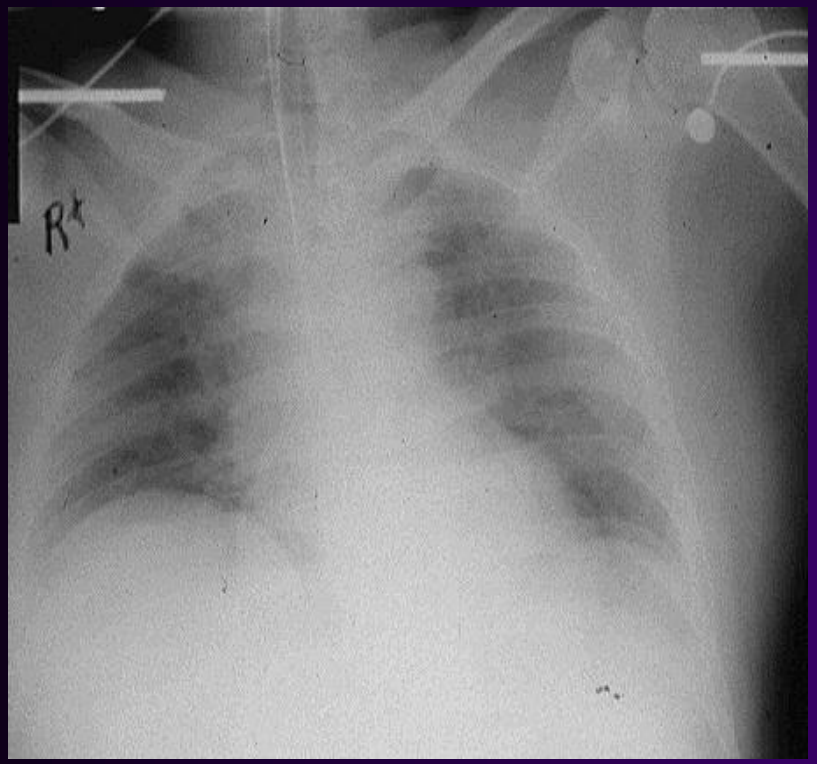
VENTILATION WITH LOWER TIDAL VOLUMES AS COMPARED WITH TRADITIONAL TIDAL VOLUMES FOR ACUTE LUNG INJURY AND THE ACUTE RESPIRATORY DISTRESS SYNDROME

THE ACUTE RESPIRATORY DISTRESS SYNDROME NETWORK*

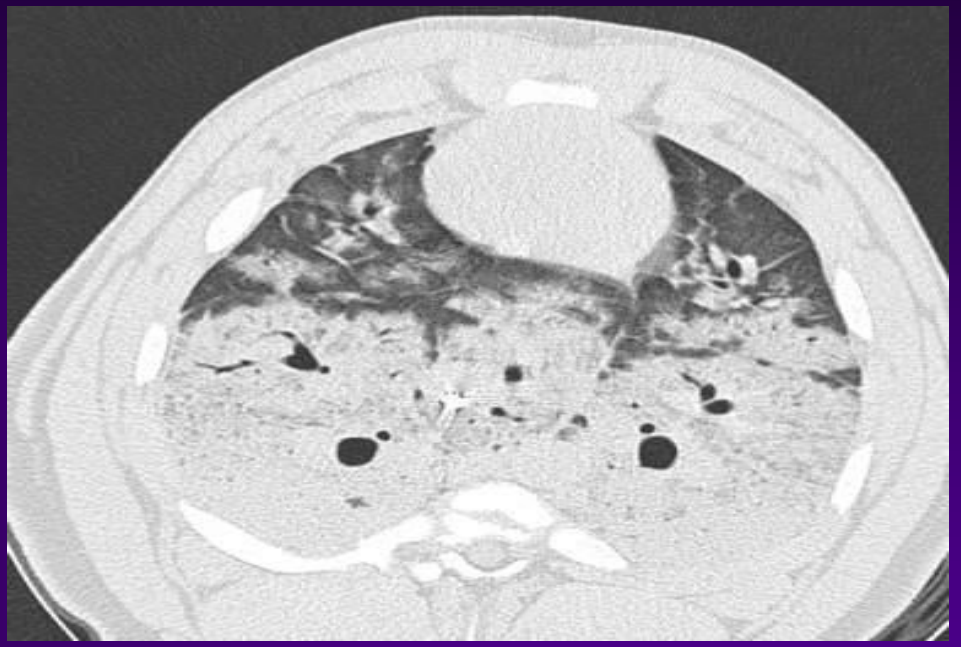
- Compared High V_T (12mL/ kg) to Low V_T (6 mL/kg) in severe ARDS/ ALI.
- Study was halted at 831 patients because mortality was significantly lower in the Low V_T (31.0%) group than the High V_T group (39.8%).

Still, mortality of 31% is unacceptably high, right?

Gravity dependence in lung disease



ARDS: A-P CXR, supine

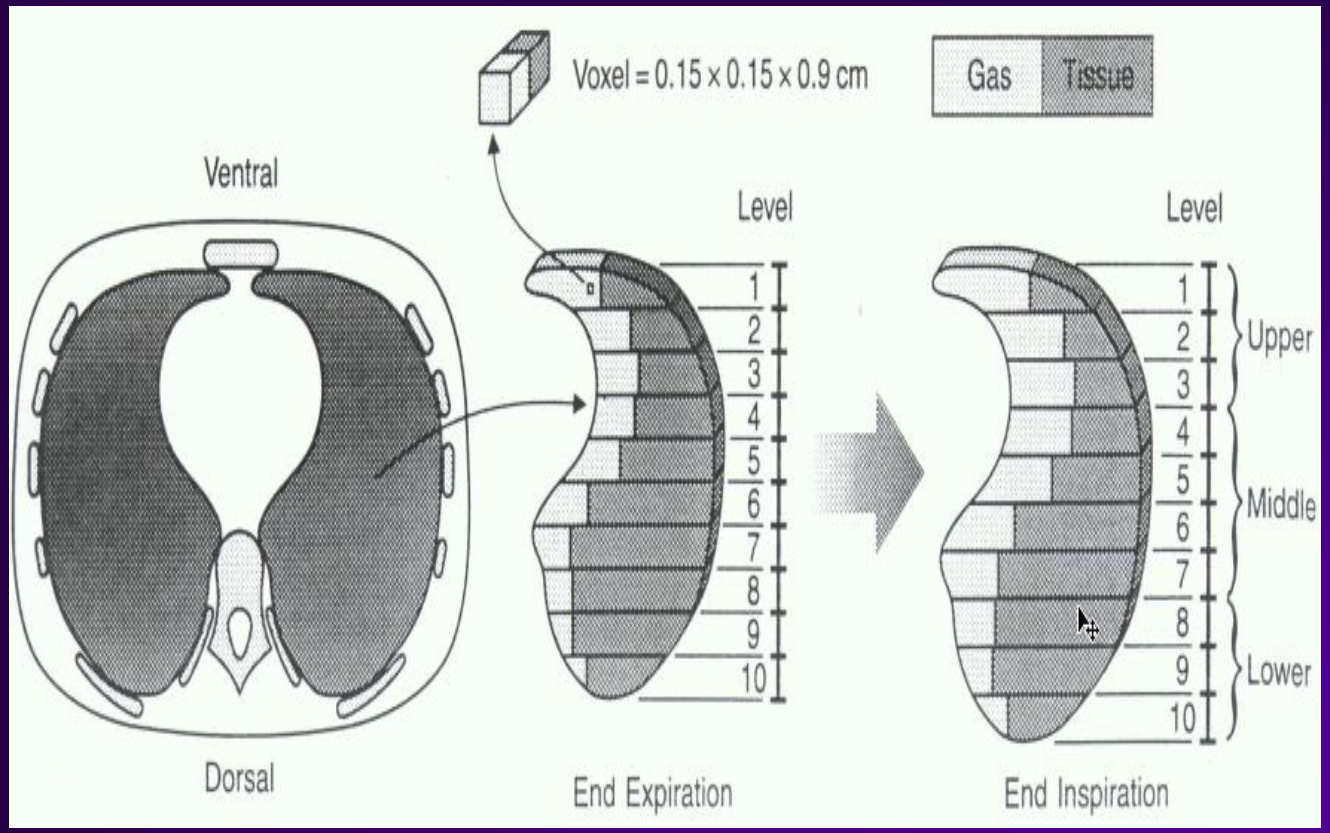


ARDS: CT scan, supine

Effects of Positive End-Expiratory Pressure on Regional Distribution of Tidal Volume and Recruitment in Adult Respiratory Distress Syndrome

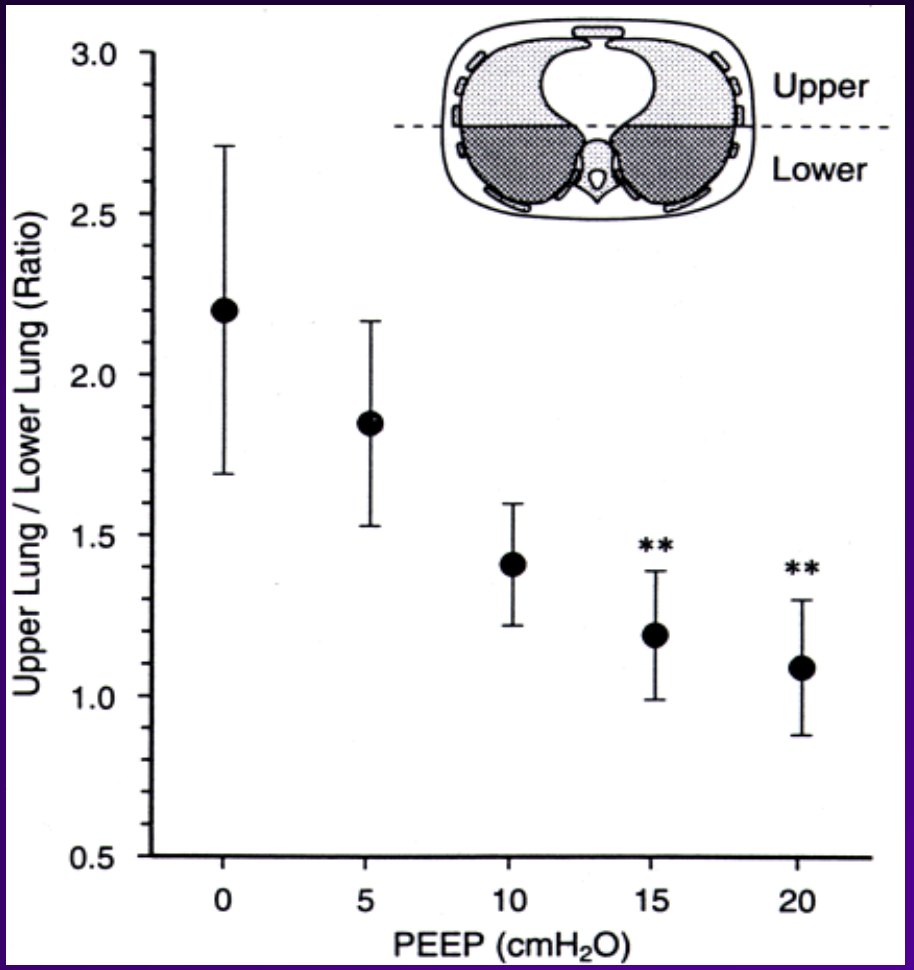
Gattinoni, Pelosi, Crotti, Valenza: Am J Resp Crit Care Med 1995

ARDS
is not a diffuse lung disorder



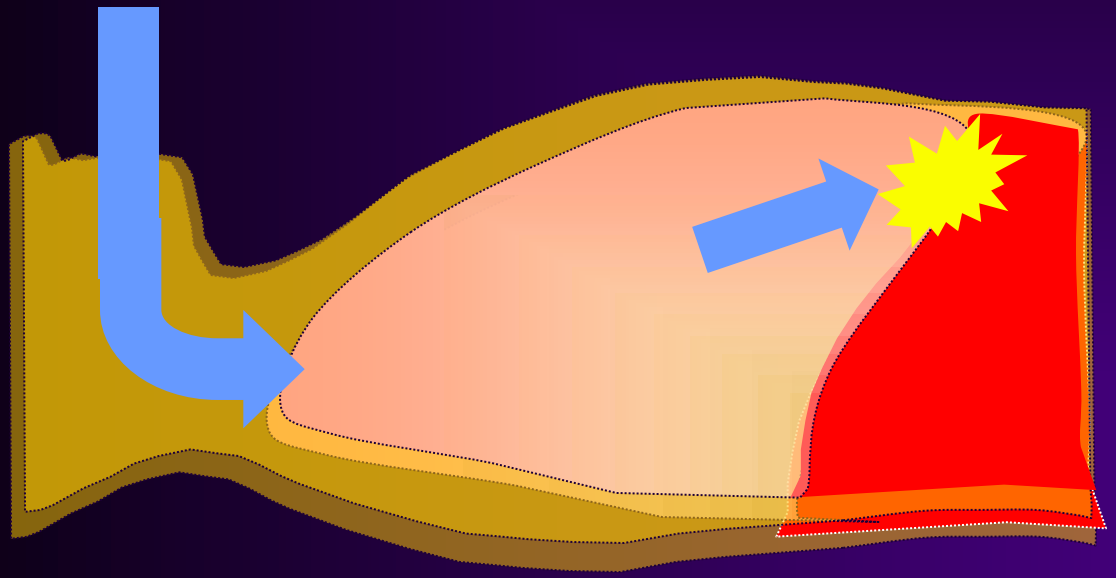
Effects of PEEP in ARDS/ ALI

- lung volume recruitment
- more homogenous gas distribution
- decreased Q_S/Q_T
- improved oxygenation
- may overdistend “healthy” lung areas
- shear forces of PPV may injure lung further



Gattinoni, et al: Am J Resp Crit Care Med 1995

Positive Pressure Ventilation preferentially ventilates non- dependent areas of the lungs



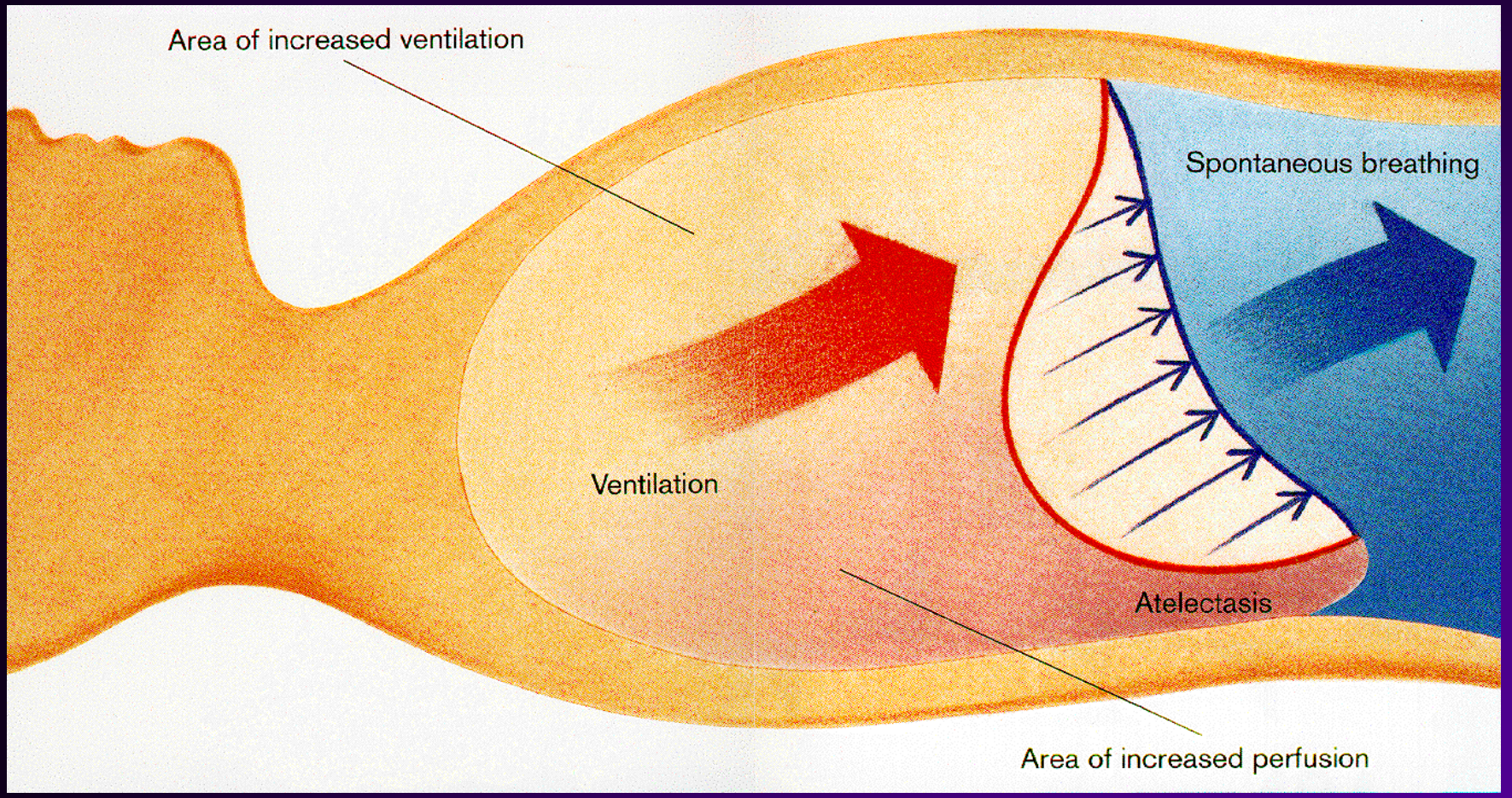
Volutrauma!

Biotrauma!

Atelectrauma!

Starts an “inflammatory cascade” which may lead to multi- organ systems failure, and high risk of death.

Use the other “Mode” of ventilation: Spontaneous Breathing

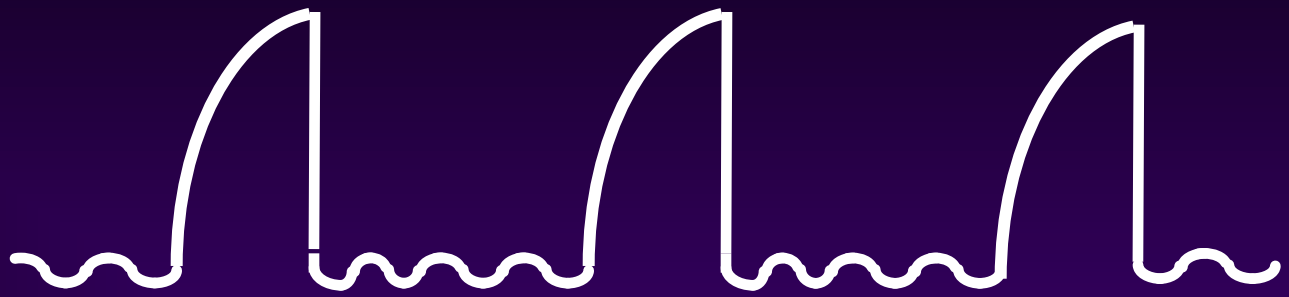


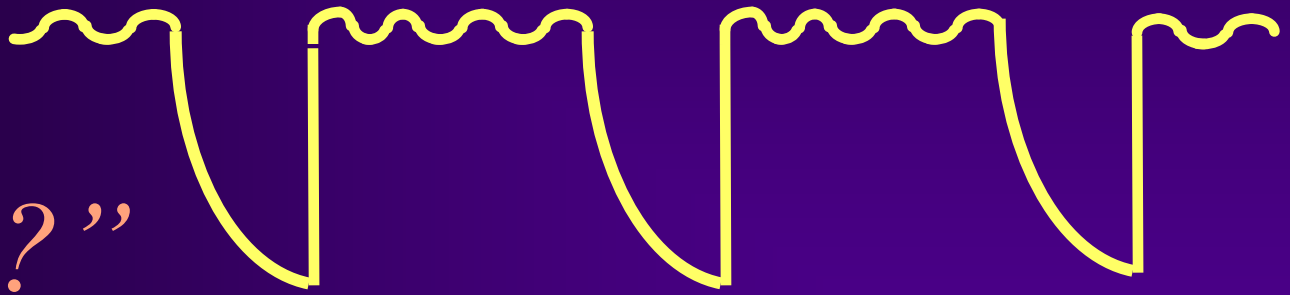
1979- 1985

Tx of Acute Respiratory Failure with High- level Face CPAP

- John B Downs, MD, et al

"If this...





why not this?"

Airway Pressure Release Ventilation

What is it ?

- CPAP at level for lung recruitment
- spontaneous breathing during CPAP

with:

- intermittent release of pressure for ventilation
- short release time that doesn’t cause loss of FRC

Pulmonary Mechanics of Spontaneous and Mechanically Assisted Breaths

Breath type	△ P cm H2O	Vt mL/ kg	C/ kg mL/ cm H2O/ kg	Raw cm H2O/ L/ sec
Mechanical (n=9)	**16.0 ± 4.2**	**5.6 ± 1.3**	**0.41 ± 0.19**	**71.5 ± 40**
Spontaneous (n=9)	**8.0 ± 3.6** ***	**3.0 ± 1.0** **	**0.61 ± 0.39**	**29.5 ± 24** ***

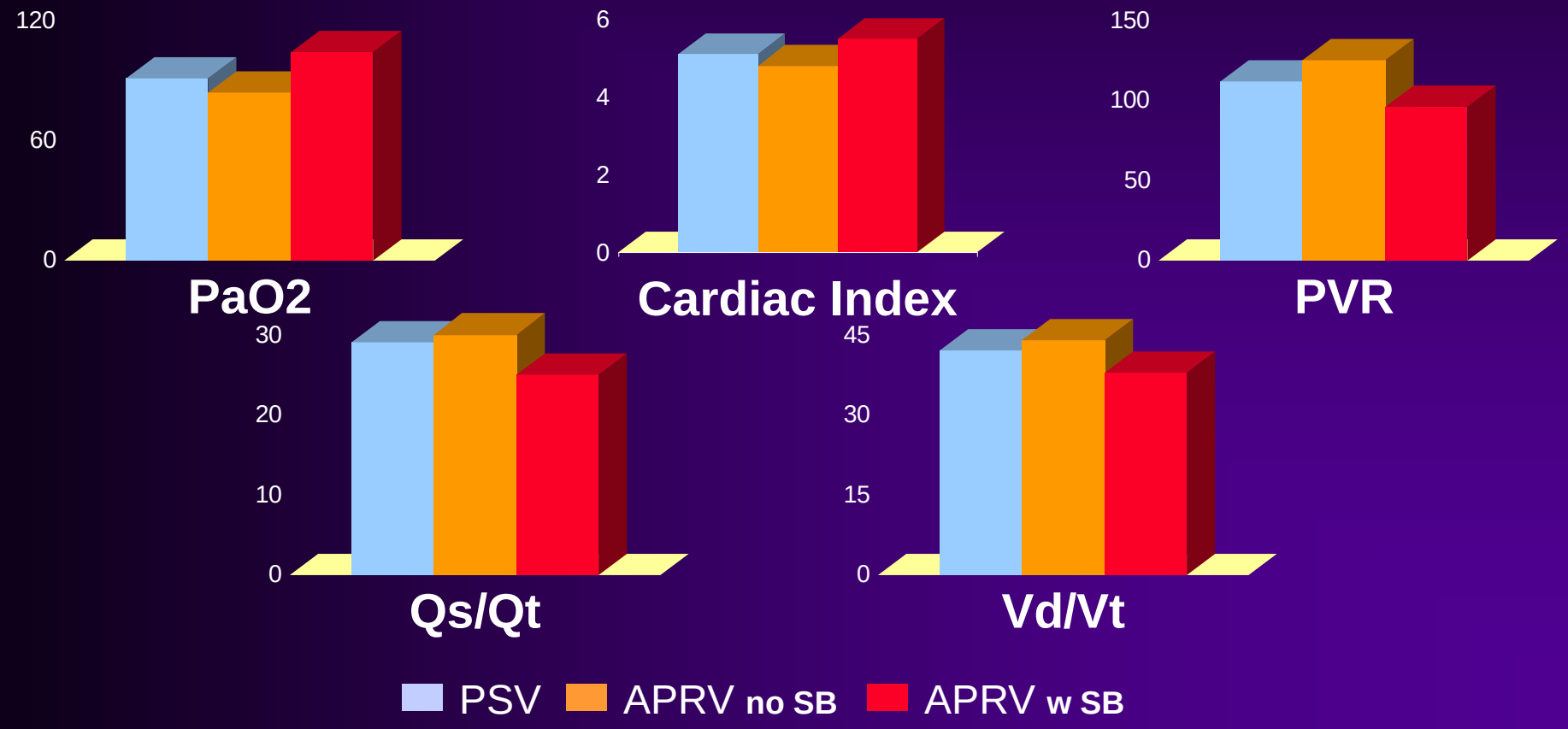
* $P < 0.05$ ** $P < 0.01$ *** $P < 0.001$ *

Mammel, Fisher, Bing. Pediatric Pulmonology, 1990

Spontaneous Breathing During Ventilatory Support Improves Ventilation- Perfusion Distributions in Patients with ARDS

adapted from: Putensen, Mutz, Putensen- Himmer, Zinserling: Amer J Resp CCM 1999

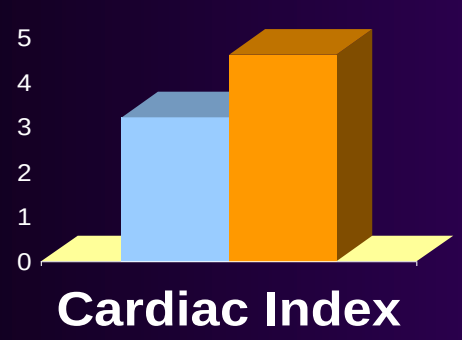
- 24 adults randomized to PSV, APRV with and without spontaneous breathing
- comparison at equal Paw or equal Ve (12 each group)
- 12 ± 3 days ventilatory support, 71% (17/ 24) cumulative survival

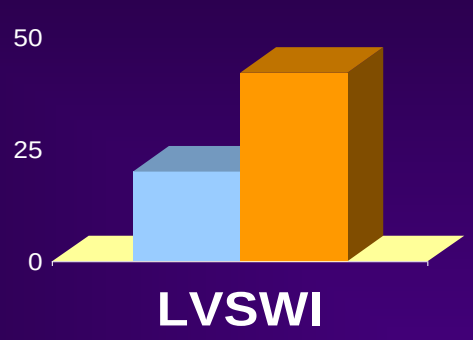


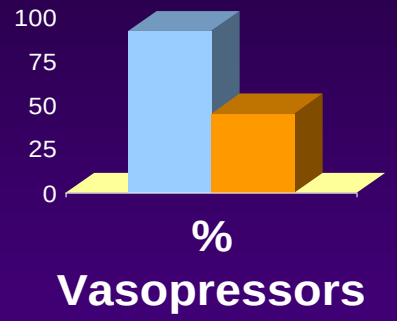
Airway Pressure Release Ventilation (APRV) Enhances Cardiac Performance in Patients with ALI/ ARDS

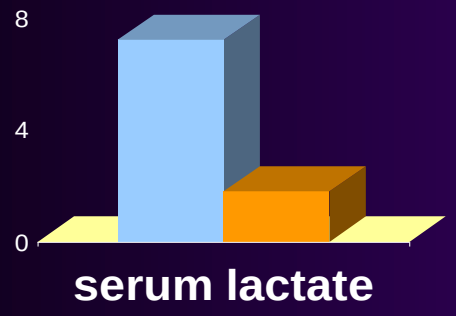
adapted from: Kaplan, Bailey, Formosa: Crit Care 2001

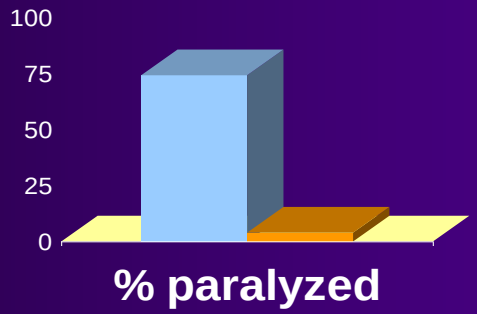
- 12 adults crossed over from PCV or PCV-IR to APRV
- improved hemodynamics and oxygenation at lower peak and mean Paw
- less sedation, no paralytics with APRV

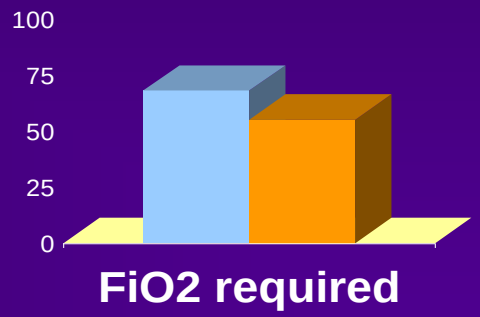












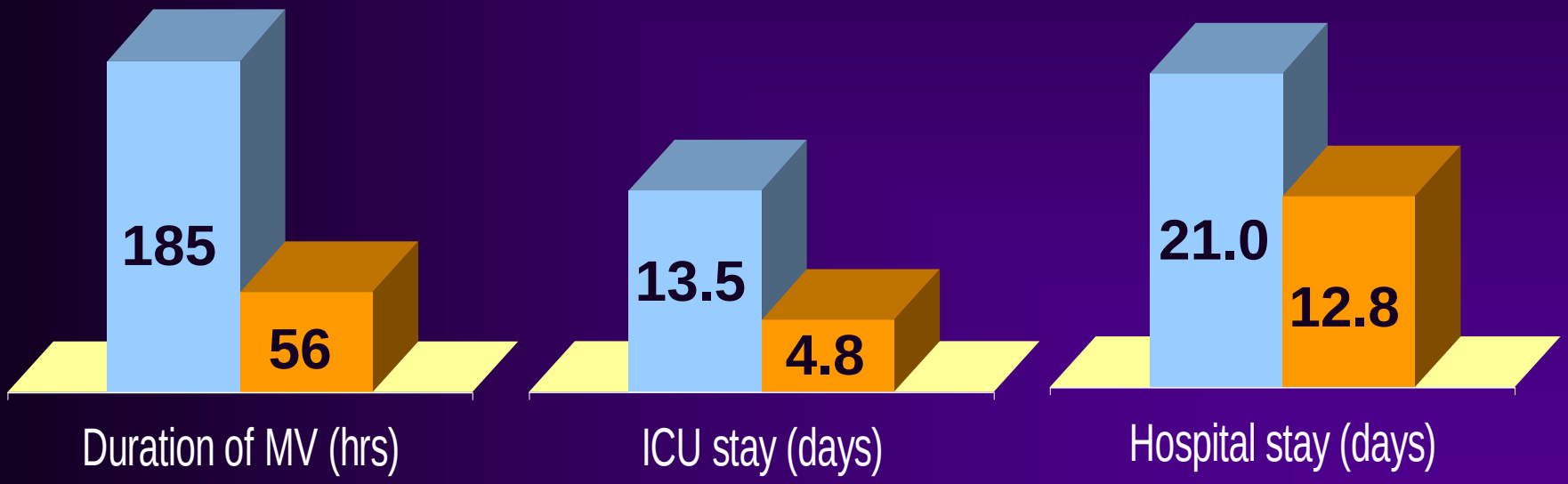
PCV (NO SB)

APRV (allowed SB)

The Use of Continuous I.V. Sedation is Associated with Prolongation of Mechanical Ventilation.

adapted from: Kollef MH, Levy NT, Ahrens TS, et al: Chest, 1998

- Prospective study of 242 ventilated ICU patients
- 93 received continuous I.v. sedation
- 149 received either bolus (64) or no (85) sedation



$p < 0.001$

Long- Term Effects of Spontaneous Breathing During Ventilatory Support in Patients with Acute Lung Injury

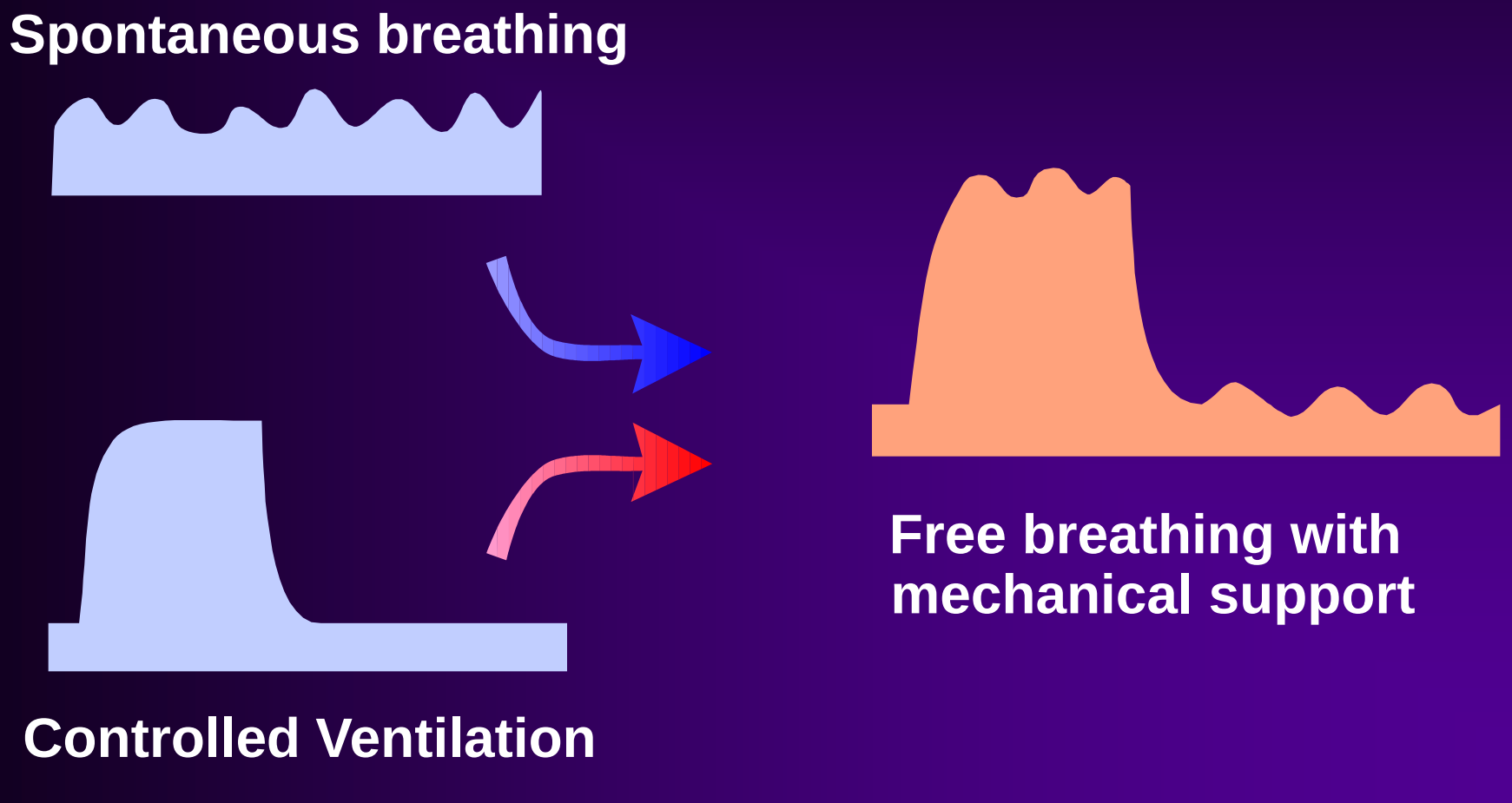
Putensen, Zech, Wrigge, et al: Amer J Resp CCM 2001

- 30 trauma adults randomized to PCV or APRV for 72 hours
- APRV allowed spontaneous breathing, PCV group received NMB
- APRV group had better Crs, PaO2, CI, DO2, V/Q

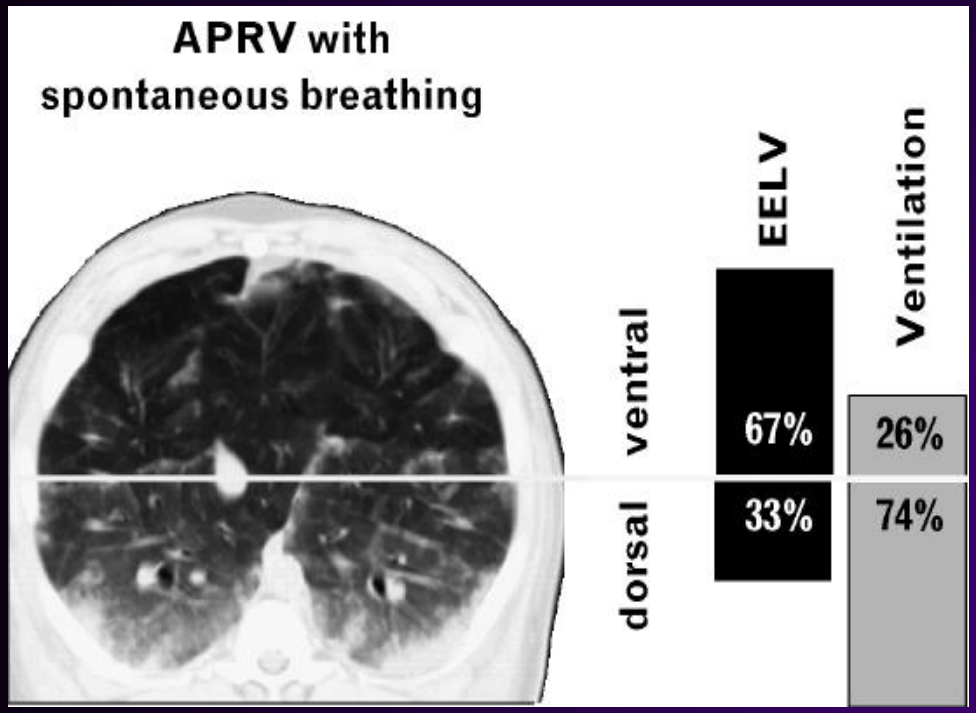
	APRV	PCV
Survivors, n (%)	12 (80)	11 (74)
ARDS, n (%)	3 (20)	11 (74)
ALI non ARDS, n (%)	8 (53)	4 (27)
sepsis, n (%)	9 (60)	10 (67)
Duration of MV, days	15 ± 2	21 ± 2
Duration of intubation, days	18 ± 2	25 ± 2
ICU stay, days	23 ± 2	30 ± 2

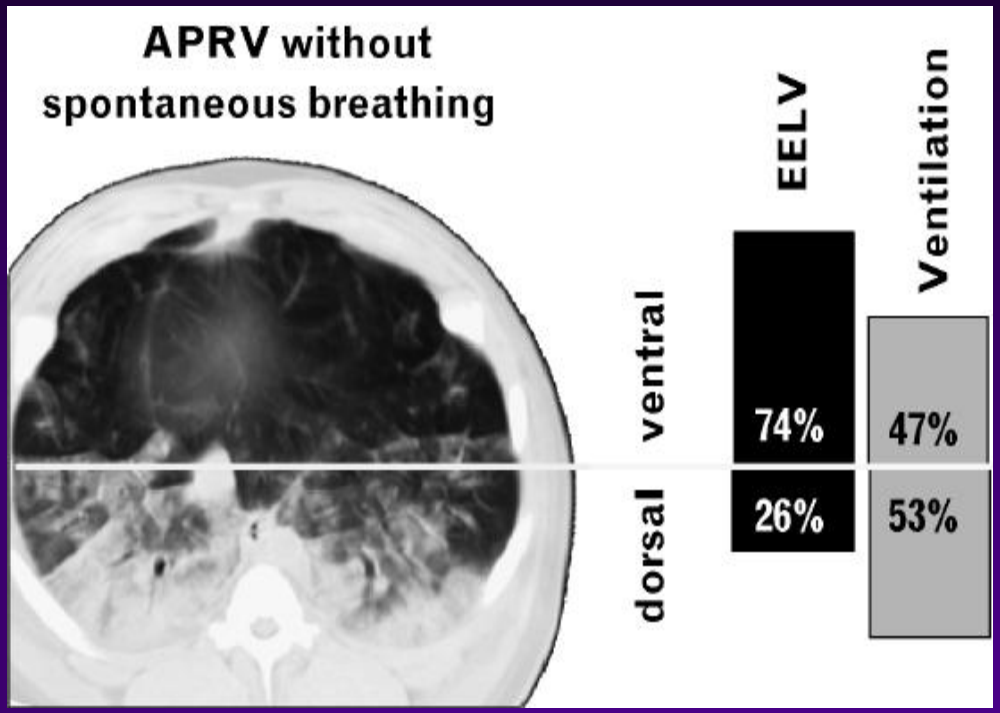
YELLOW = $p \leq 0.03$

1995- Introduction of “free breathing” during mechanical ventilation via active expiration



Decreased Atelectasis with Spontaneous Breathing during MV





SB favors ventilation distribution in gravity- dependent regions

Putensen C, Muders T, Varelmann D, Wrigge H. *The impact of spontaneous breathing during mechanical ventilation.* Current Opinion in Critical Care, 2006

What about using PSV to overcome spontaneous breathing WOB with high CPAP or APRV?

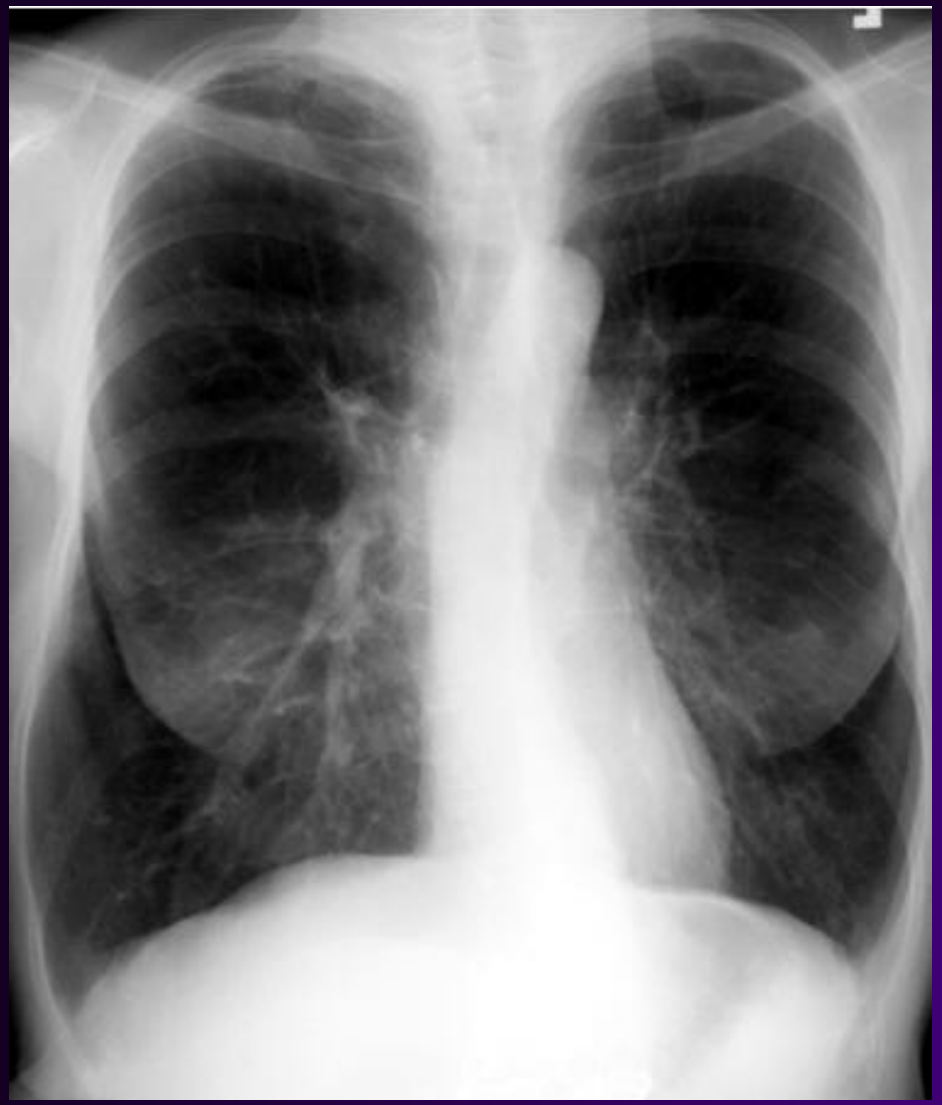
Spontaneous ventilation (unassisted) is associated with improved ventilation/perfusion distribution, unlike PSV.

[The] imposition of PSV to APRV reduces the benefits of spontaneous breathing ... as flow and pressure development are uncoupled from patient effort.

Ultimately, PSV during APRV defeats improvements in distribution of ventilation and V/Q matching associated with unassisted spontaneous breathing.

Habashi, N M. Crit Care Med 2005 Vol. 33, No. 3 (Suppl.)
(6 references cited)

Obstructive Lung Disease



CLD

COPD

Emphysema

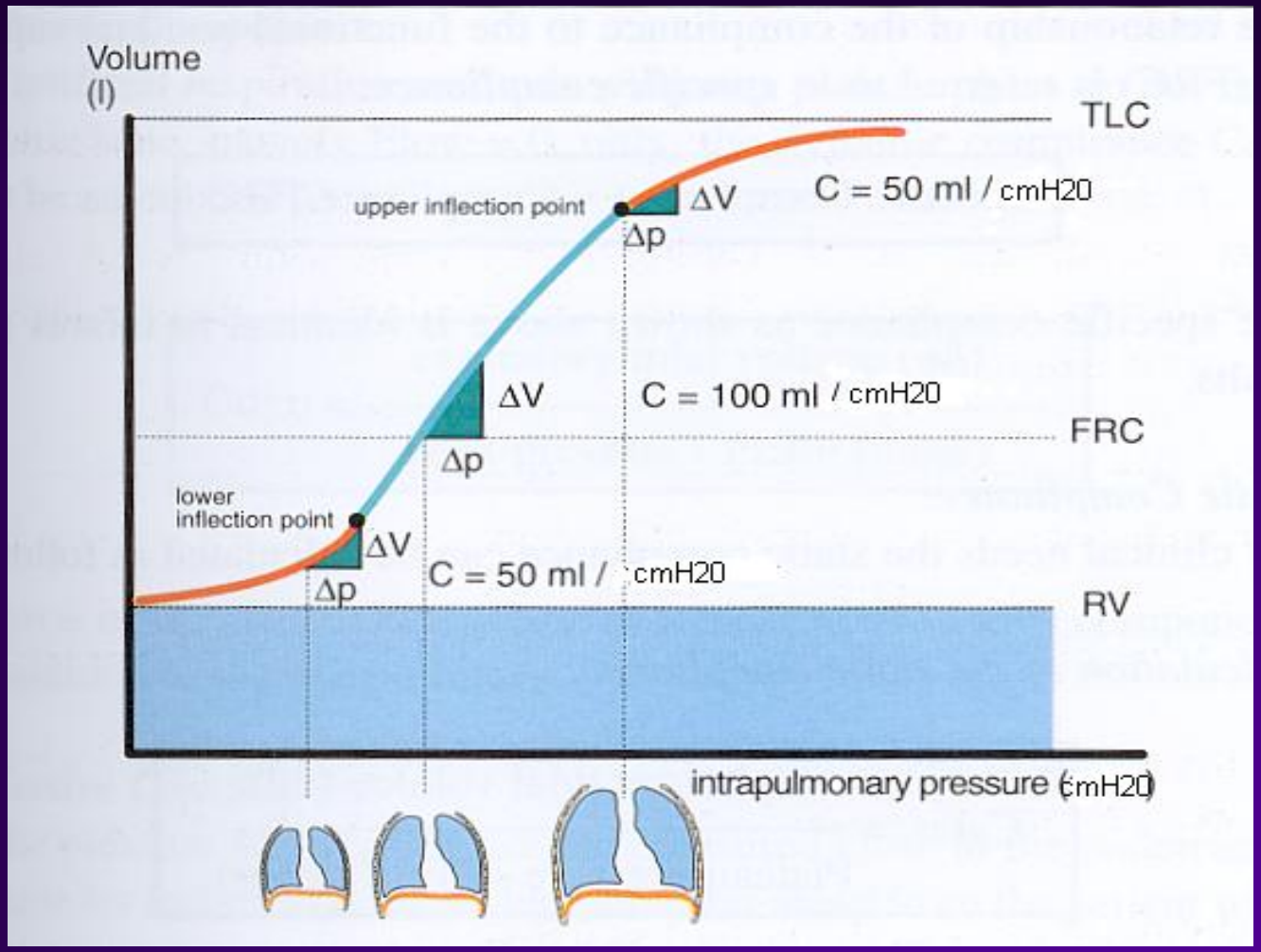
Chronic Bronchitis

Asthma

Increased lung volume results in increased work of breathing

Livin' high on the curve:

- **WOB high (less V for the P)**
- **gas trapping**
- **increased V_D/ V_T**
- **inability to increase Ve by rate**



Obstructive Lung Disease:

A completely different set of problems should dictate different strategies

- support / reduce work of breathing
- minimize complications of sedation
- maximize patient comfort

Pulm toilet required?

ETT use **CPAP**/ PSV

No pulm toilet, or DNI?

NIV- **CPAP**/ PSV

The other “Mode” of ventilation:
Spontaneous Breathing

- ✓ is more physiologic than PPV breathing
- ✓ reduces sedation requirements
- ✓ eliminates need for neuromuscular blockade
- ✓ these breaths always have higher Crs & lower Raw
- ✓ improves cardiac performance & renal function
- ✓ improves / prevents V/Q mismatch
- ✓ decreases duration of MV and ICU LOS
- ✓ lower CO$TS of care
- ✓ <u>does not create further lung injury, even at larger VT</u>
- ✓ allows for patient communication, even speech

"To breathe is good...

To breathe spontaneously

is even better!"

- John B. Downs, MD

“Take Home” RCP messages:

- Use objective- based sedative and analgesic administration.
- Use current generation of ventilators that allow spontaneous breathing.
- Coach “deep- breathe and cough” for patients on MV.

In other words, take the time, and expend the effort, to treat patients, not devices!

Thank you!

Danke Schoen!