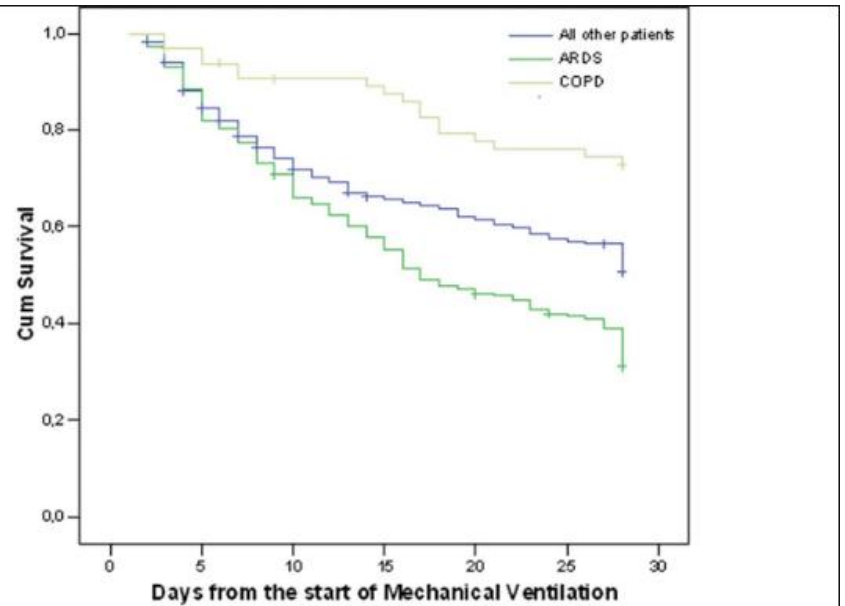
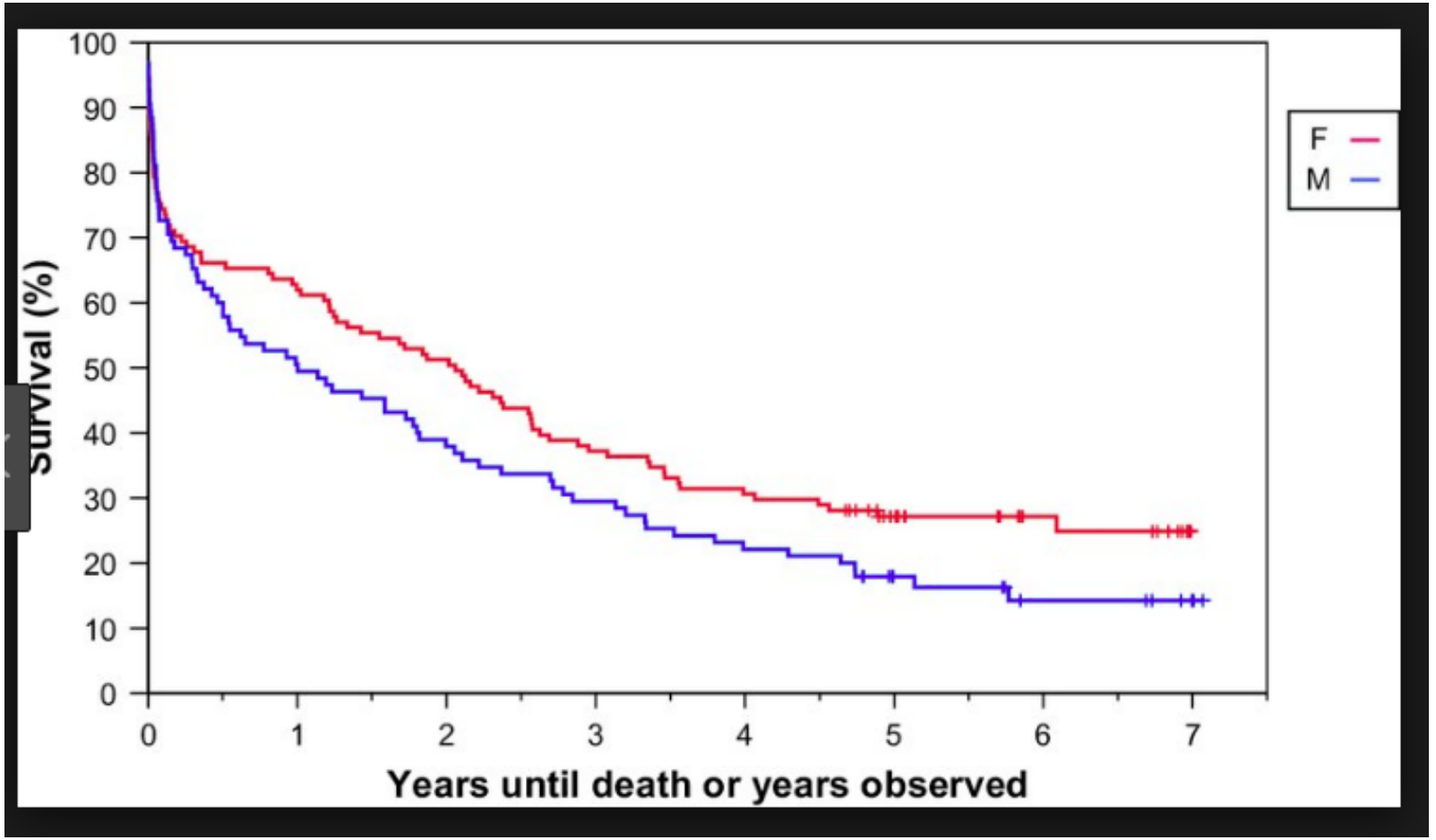
Μηχανικός αερισμός σε αποφρακτικά νοσήματα

Prognosis



Number at risk	1 day	3 days	7 days	14 days	21 days	28 days
COPD	60	59	56	54	47	44
ARDS	307	287	238	177	139	117
All others	734	694	576	481	439	408

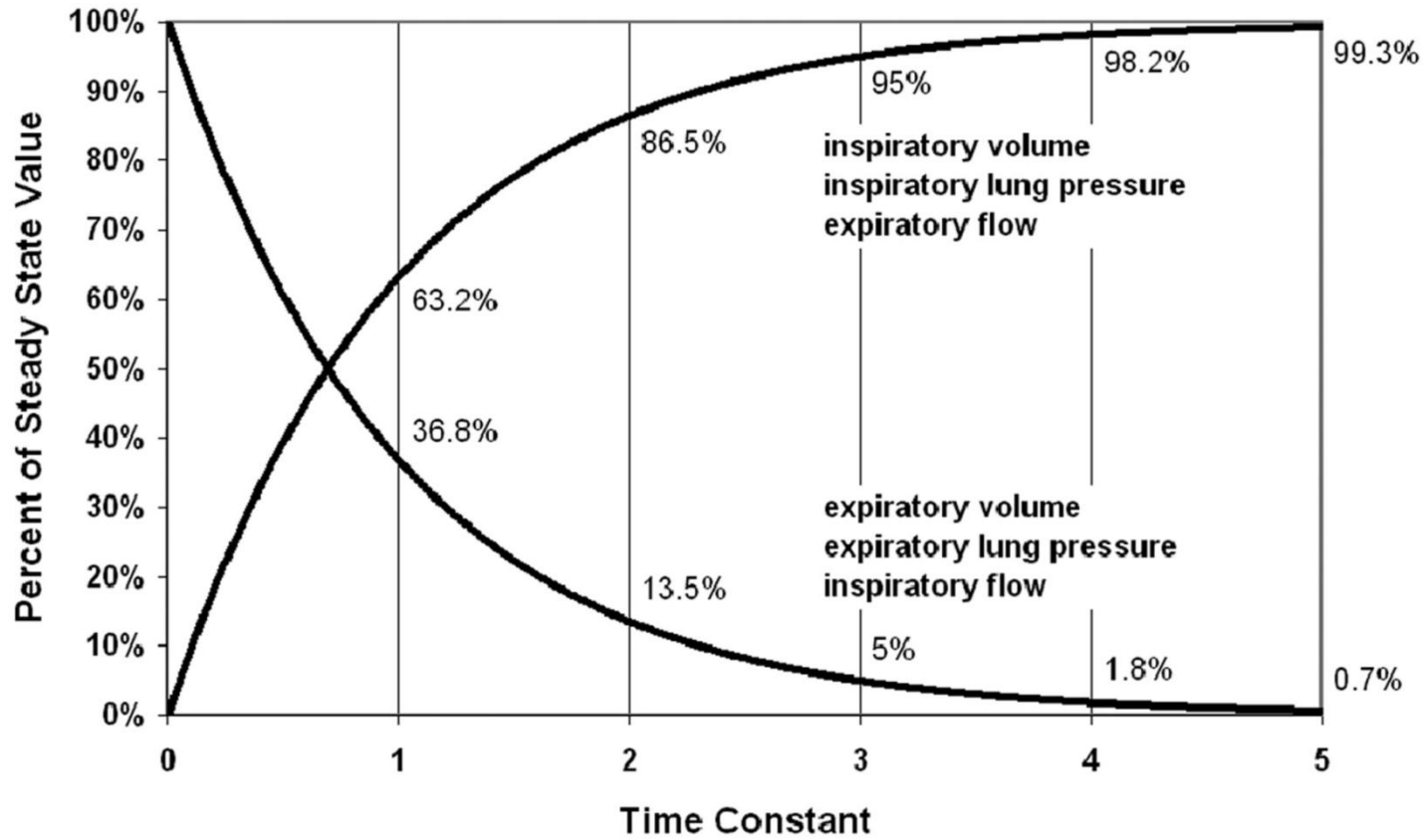

100
90
80
70
60
50
40
30
20
10
0
Survival (%)
0
1
2
3
4
5
6
7
Years until death or years observed
F
M

Εκπνοή

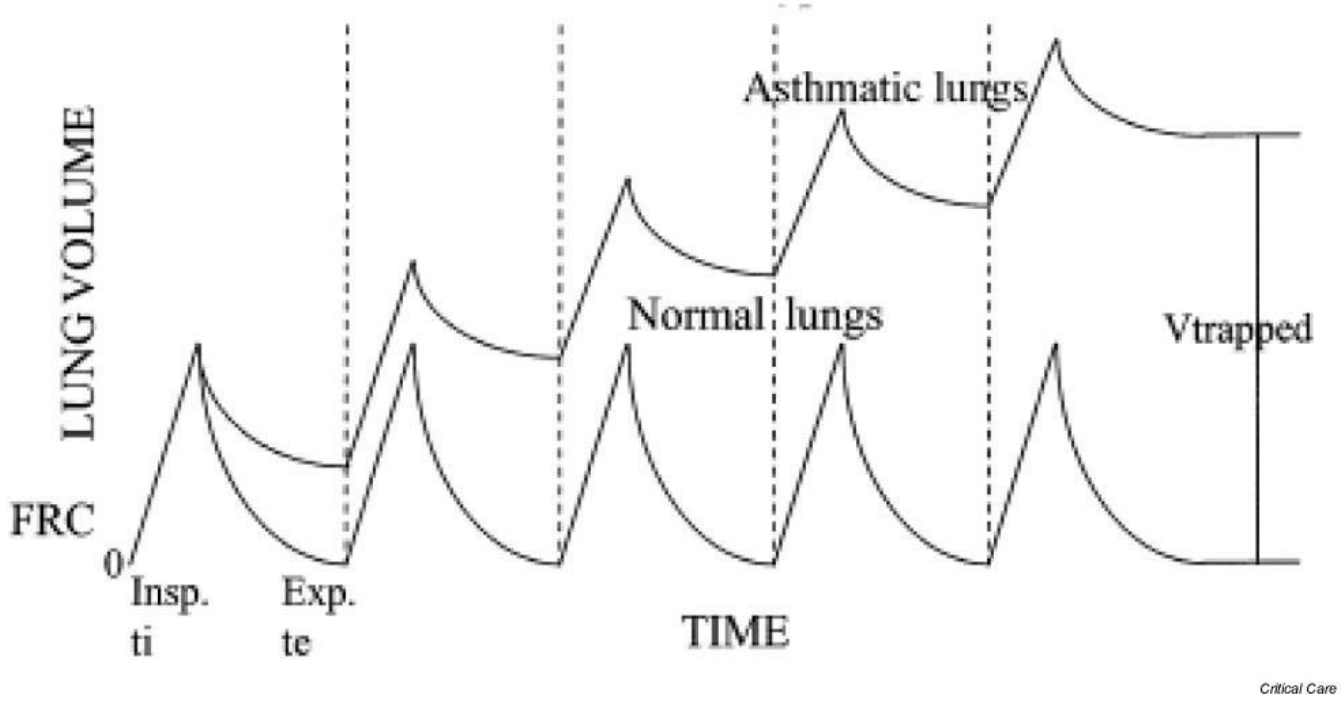
$$V_t = V_0 \times e^{-t/\tau}$$

$$\tau = RC$$

$t = 0$	$Vt = Vo$
$t = \tau$	$Vt = 0{,}37\ Vo = 37\%\ Vo$
$t = 2\tau$	$Vt = 0{,}15\ Vo = 15\%\ Vo$
$t = 3\tau$	$Vt = 0{,}05\ Vo = 5\%\ Vo$
$t = 4\tau$	$Vt = 0{,}02\ Vo = 0$

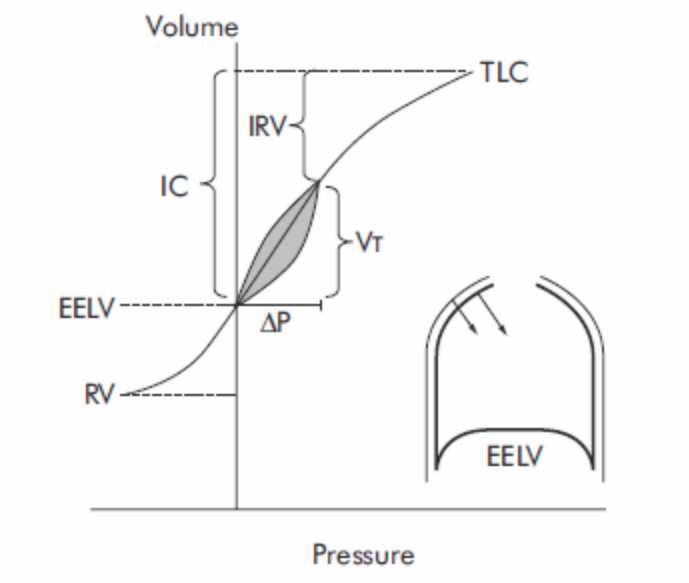

100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Percent of Steady State Value
0
1
2
3
4
5
Time Constant
63.2%
86.5%
95%
98.2%
99.3%
36.8%
13.5%
5%
1.8%
0.7%
inspiratory volume
inspiratory lung pressure
expiratory flow
expiratory volume
expiratory lung pressure
inspiratory flow

Παθοφυσιολογία

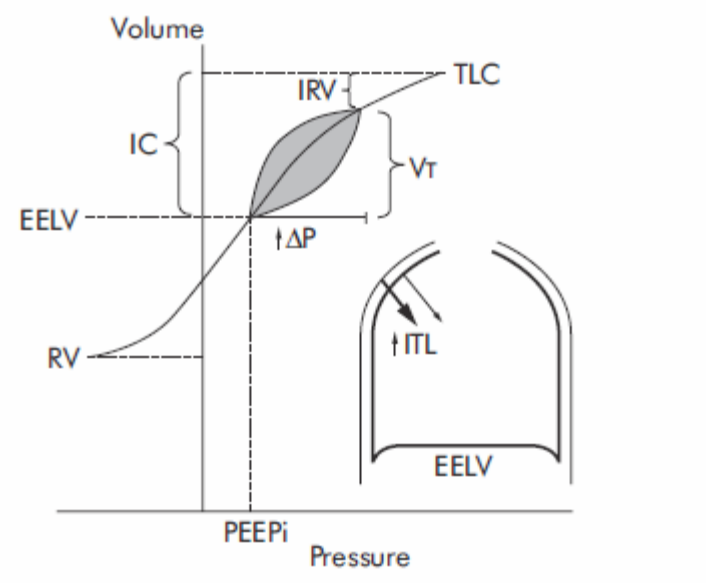


Παθοφυσιολογία της παρόξυνσης ΧΑΠ

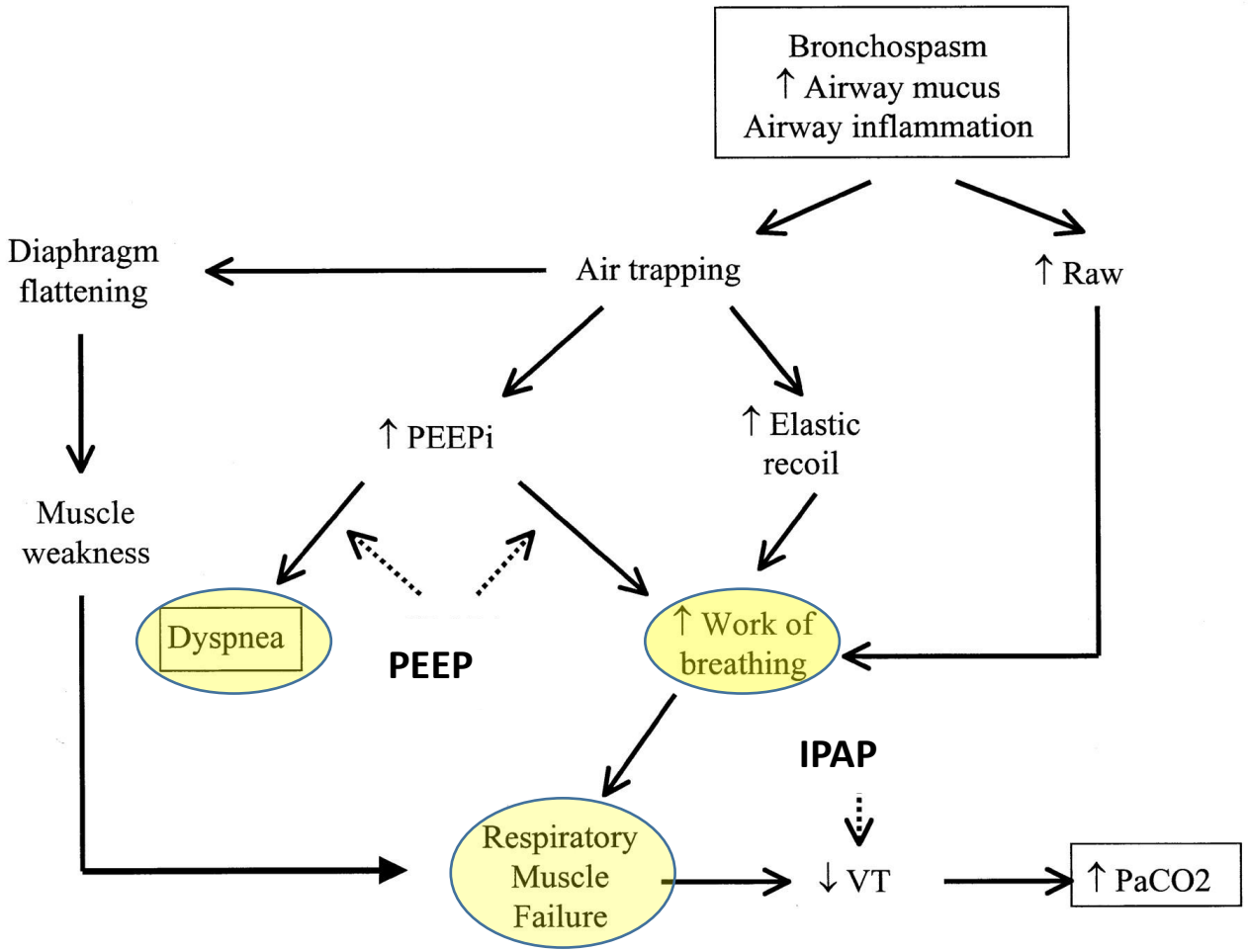
Stable COPD



COPD exacerbation

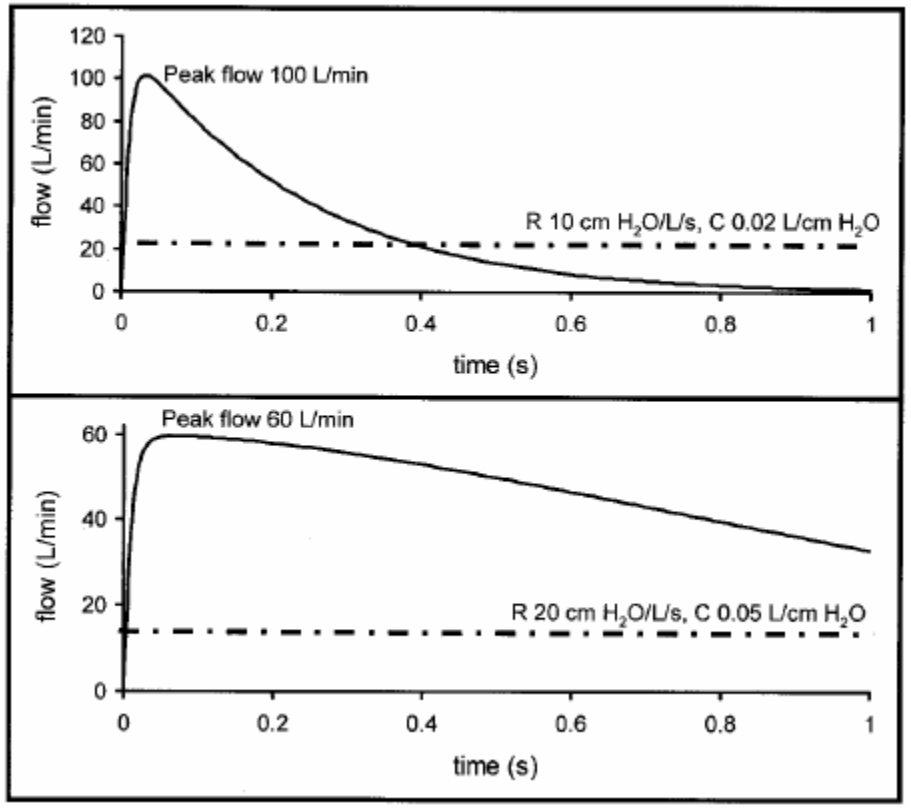


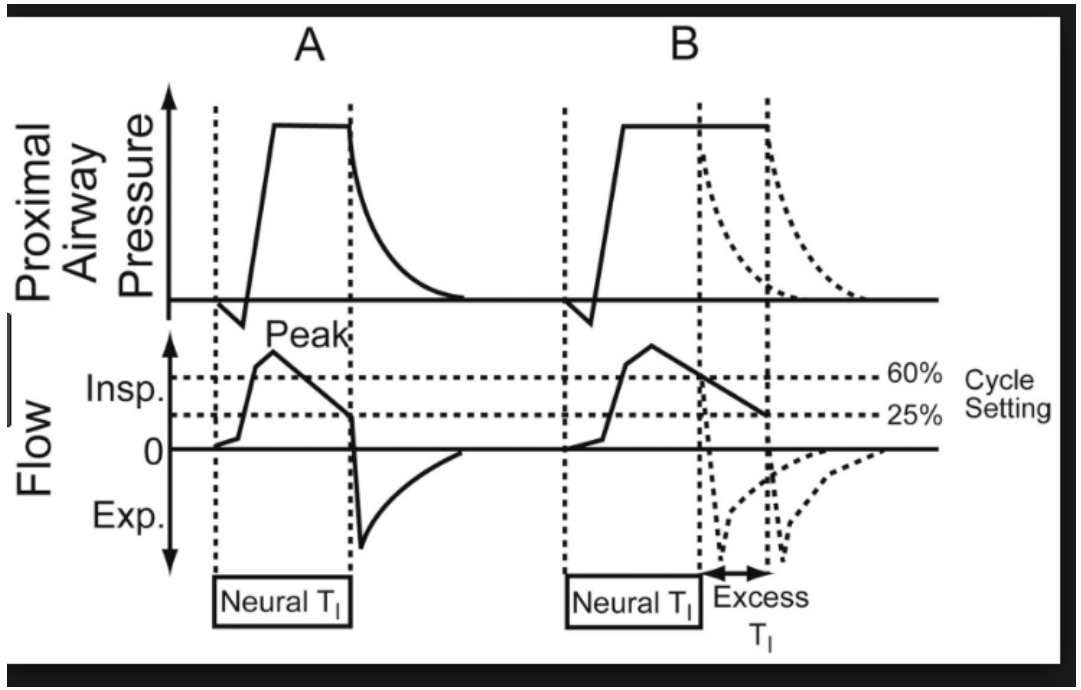
Παθοφυσιολογία

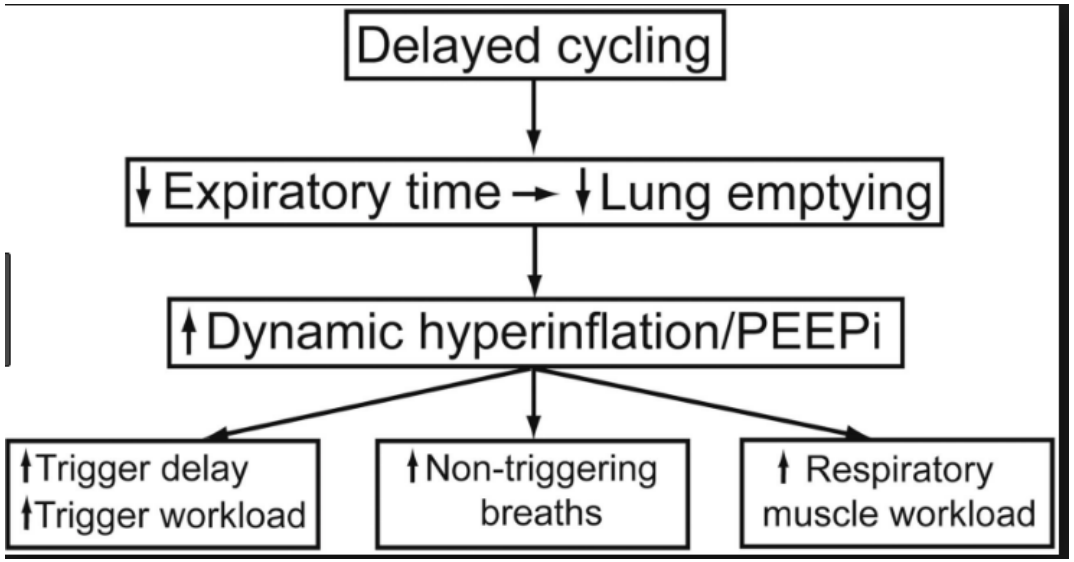


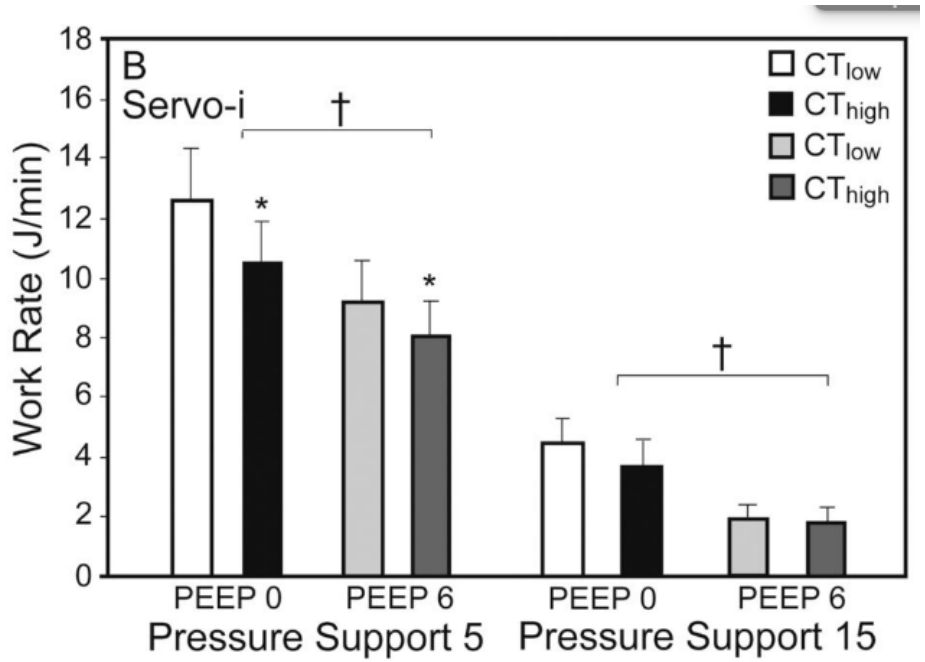
Cycling off criteria

Cycling off at 25% of peak flow (neural inspiratory time = 1 sec)




A
B
Proximal Airway Pressure
Peak
Flow
Insp.
0
Exp.
60%
25%
Cycle Setting
Neural T_I
Neural T_I
Excess T_I

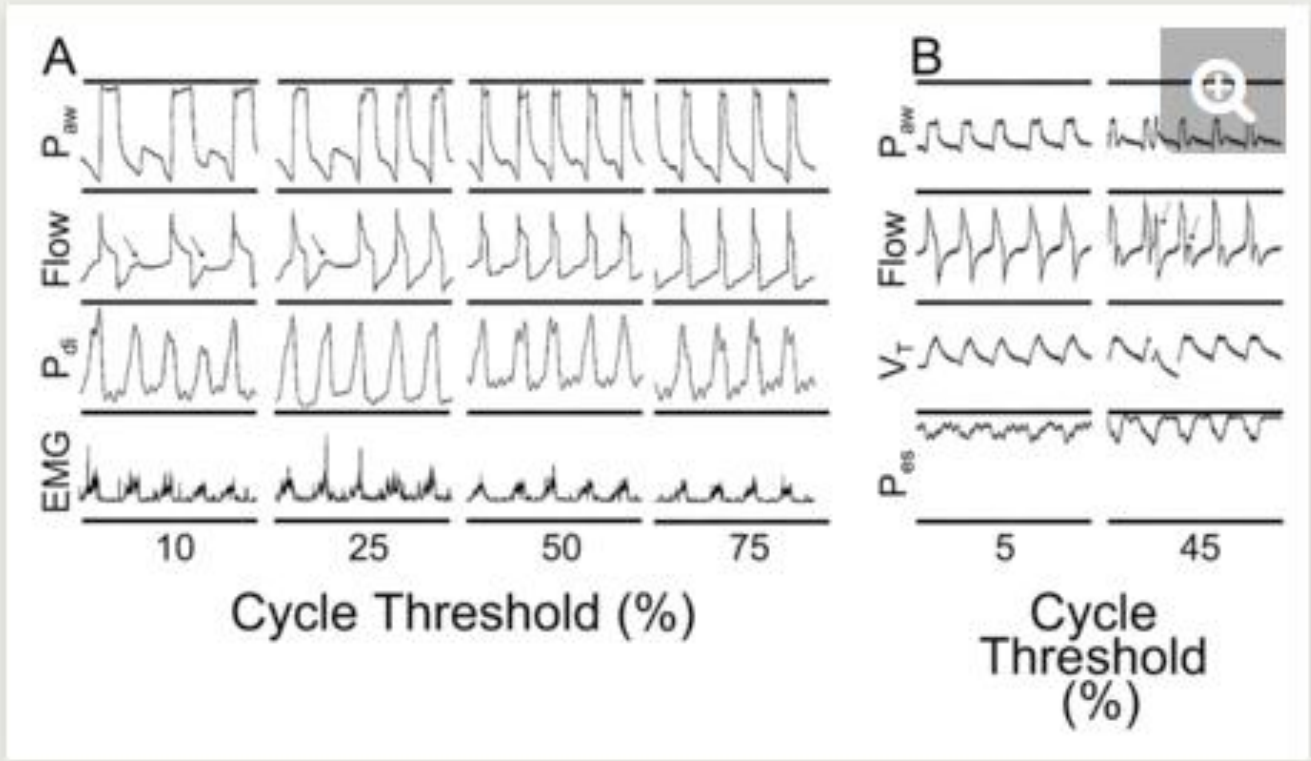

Delayed cycling
↓ Expiratory time → ↓ Lung emptying
↑ Dynamic hyperinflation/PEEPi
↑ Trigger delay
↑ Trigger workload
↑ Non-triggering breaths
↑ Respiratory muscle workload


B
Servo-i
†
†
*
*
CT low
CT high
CT low
CT high
Work Rate (J/min)
0
2
4
6
8
10
12
14
16
18
PEEP 0
PEEP 6
PEEP 0
PEEP 6
Pressure Support 5
Pressure Support 15

COPD

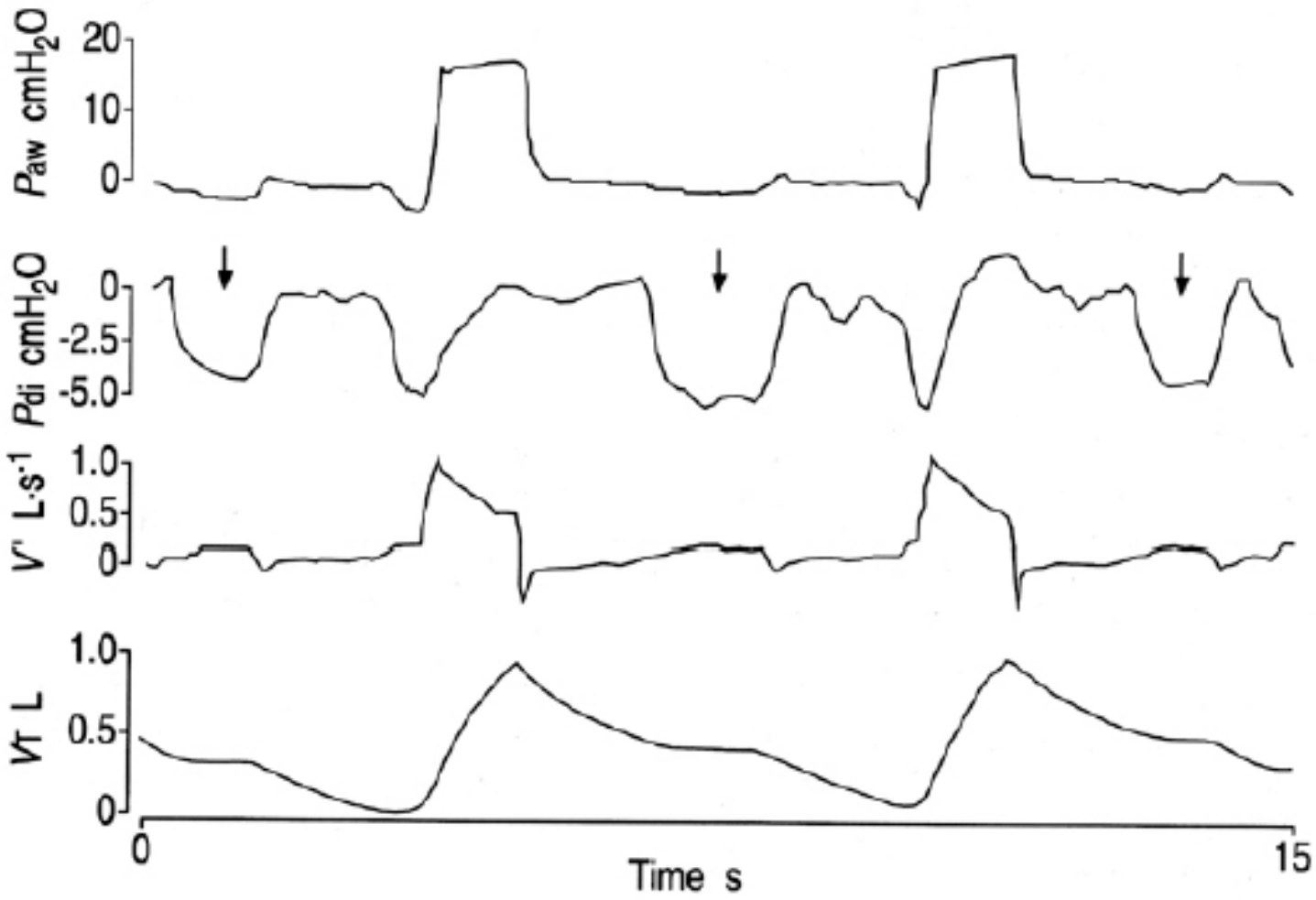
ARDS

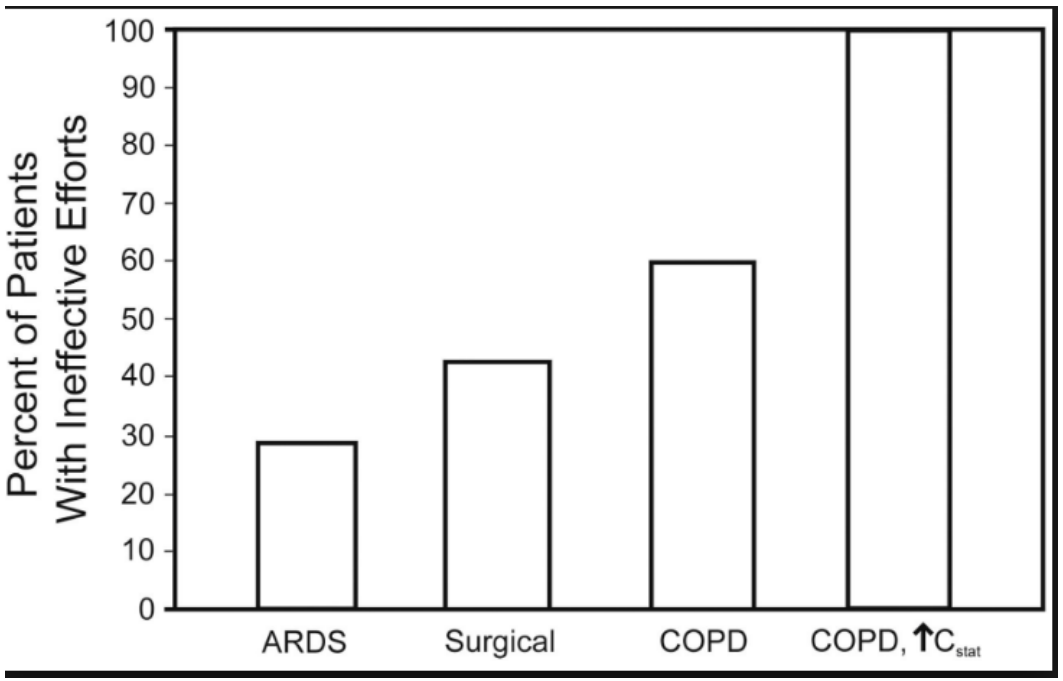
Missing efforts



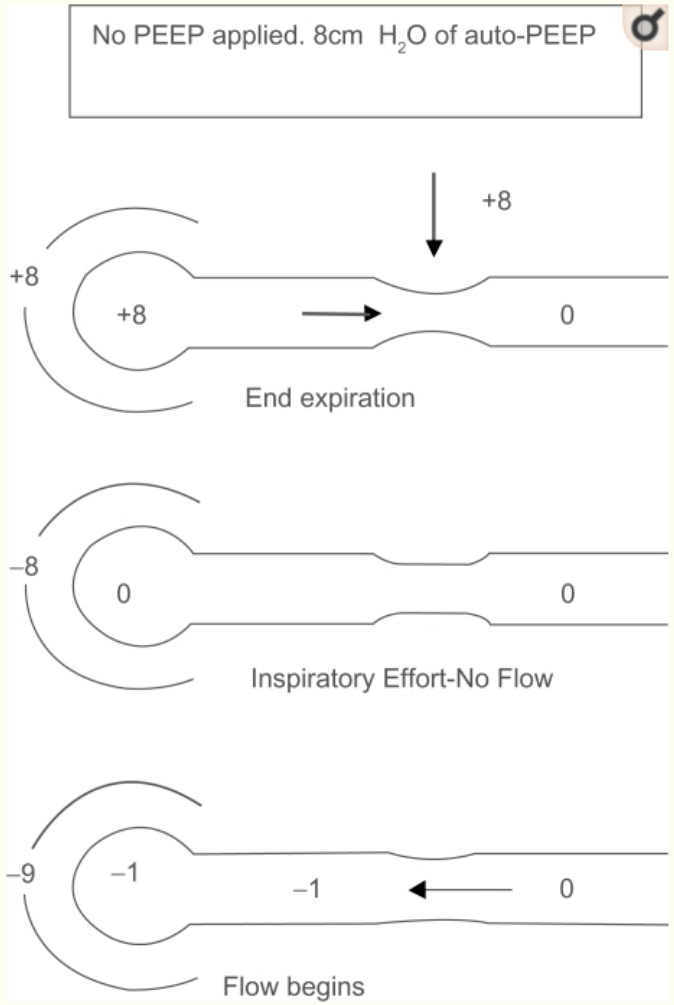
Double triggering

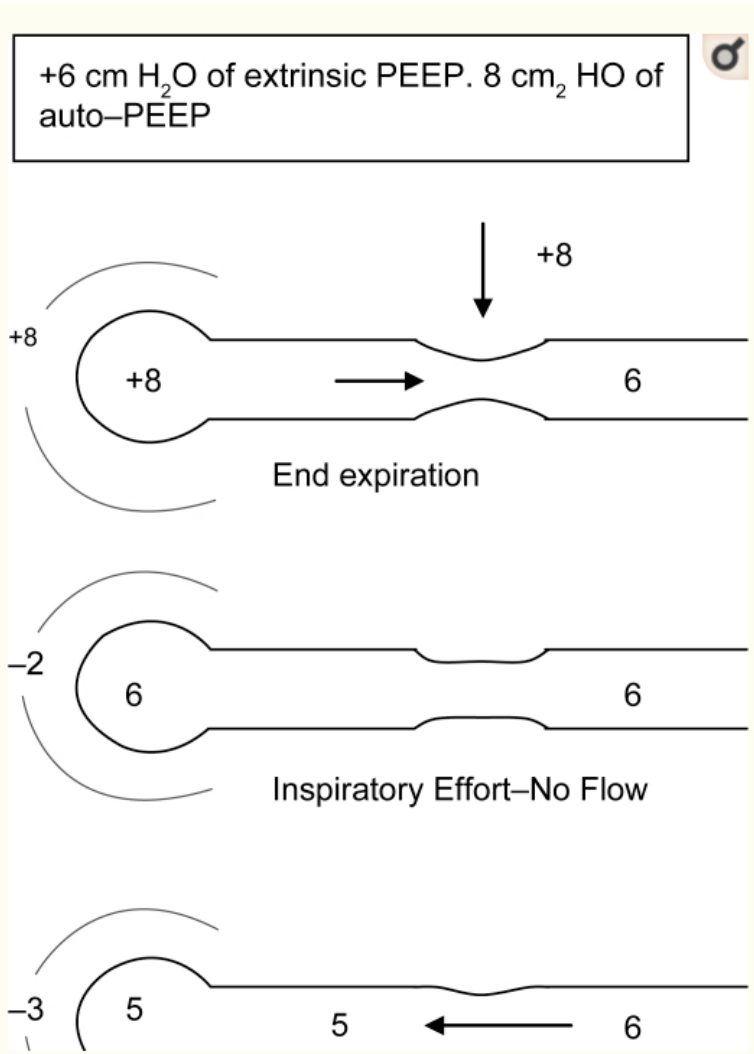
Missing efforts


P_{aw} cmH$_2$O
20
10
0
P_{di} cmH$_2$O
0
-2.5
-5.0
V' L·s^{-1}
1.0
0.5
0
V_T L
1.0
0.5
0
0
15
Time s

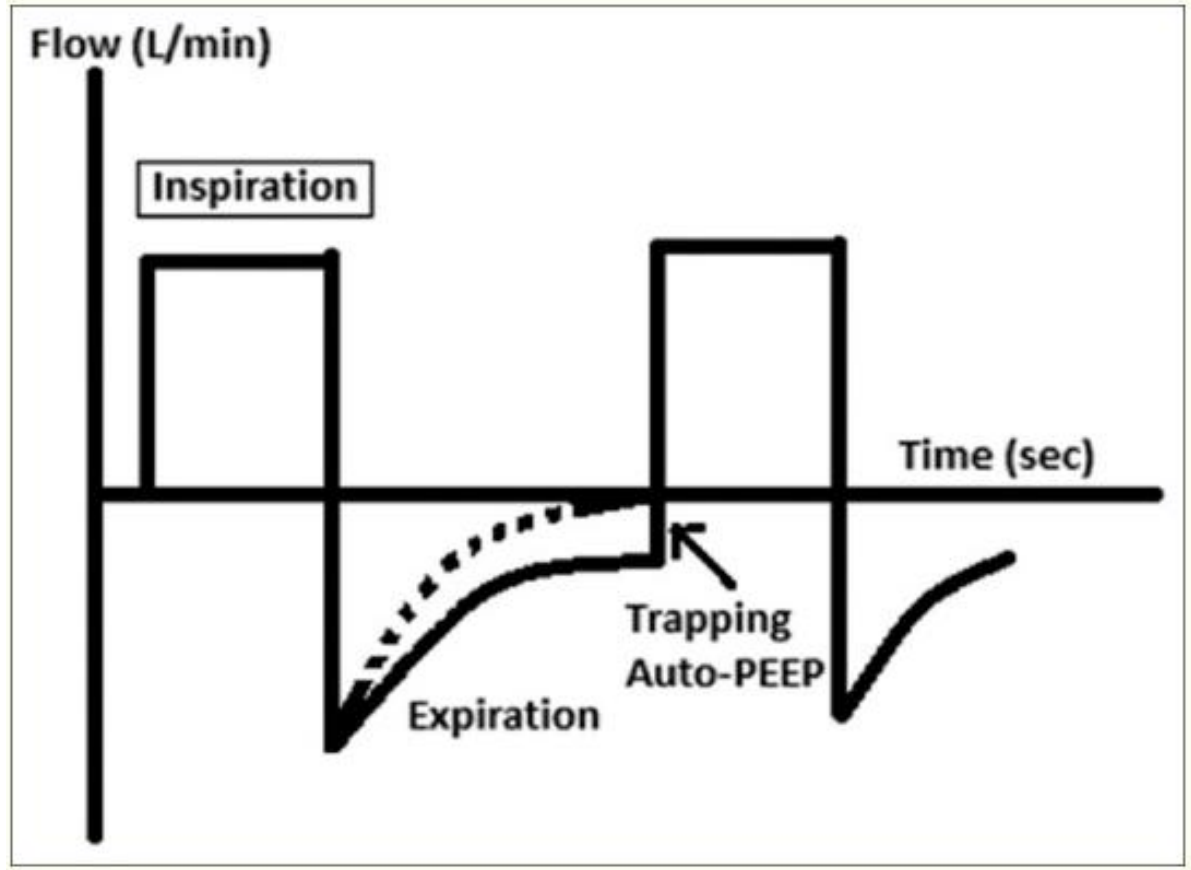

Percent of Patients
With Ineffective Efforts
100
90
80
70
60
50
40
30
20
10
0
ARDS
Surgical
COPD
COPD, ↑C_{stat}

Application of PEEPe in Pressure support


No PEEP applied. 8cm H_2O of auto-PEEP
+8
+8
+8
0
End expiration
–8
0
0
Inspiratory Effort-No Flow
–9
–1
–1
0
Flow begins


+6 cm H2O of extrinsic PEEP. 8 cm2 HO of auto–PEEP
+8
+8
+8
6
End expiration
–2
6
6
Inspiratory Effort–No Flow
–3
5
5
6

Diagnosis of dynamic hyperinflation


Flow (L/min)
Inspiration
Time (sec)
Trapping
Auto-PEEP
Expiration

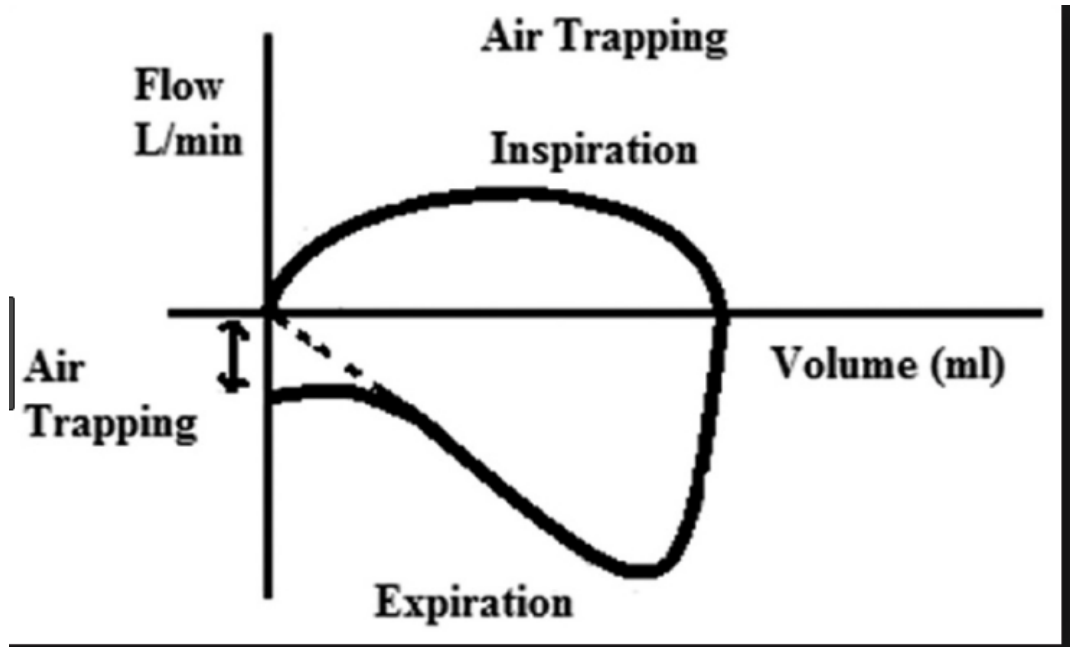
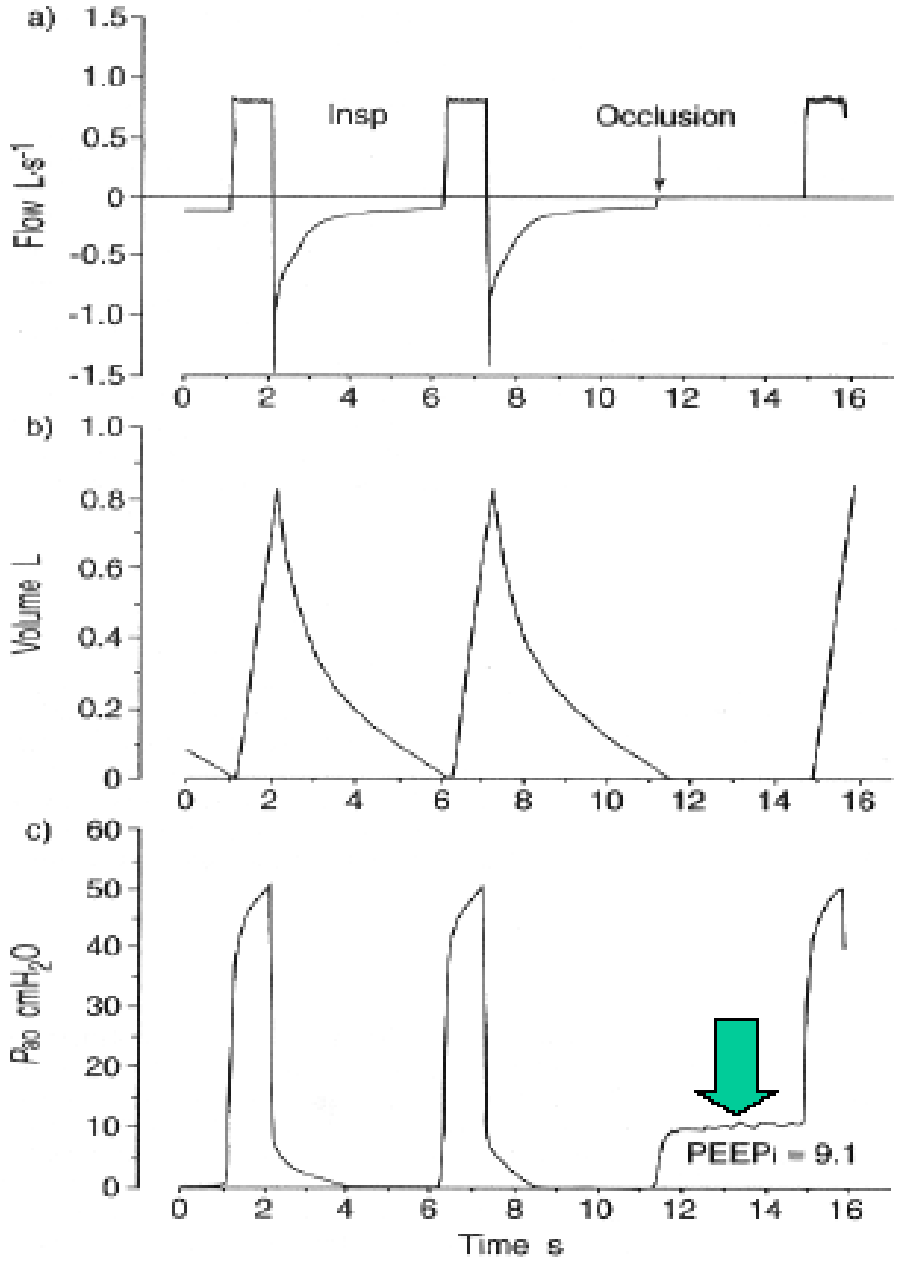

Air Trapping
Flow
L/min
Inspiration
Air
Trapping
Volume (ml)
Expiration

TABLE 31-1 Factors Determining Dynamic Pulmonary Hyperinflation and Intrinsic PEEP

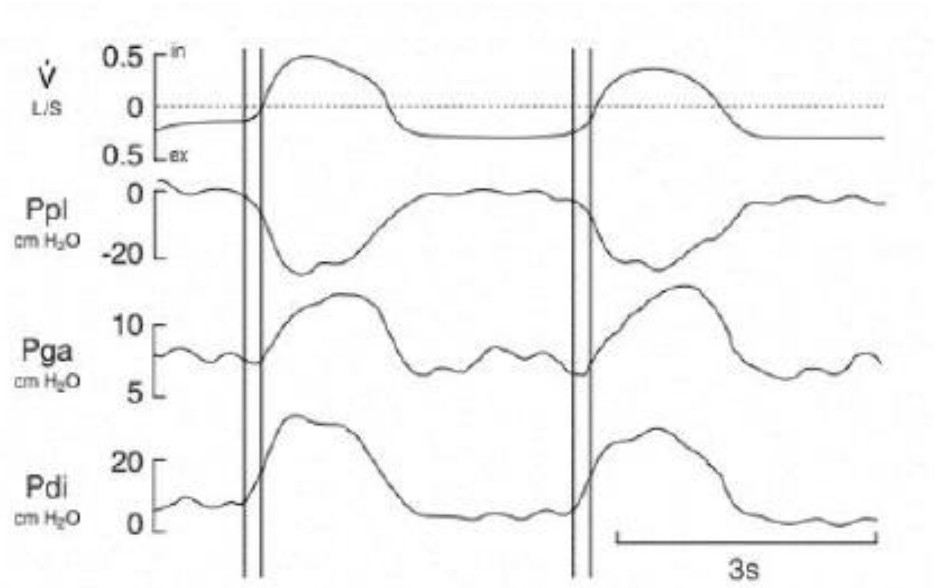
Patient respiratory mechanics
Pulmonary flow resistance
Expiratory flow limitation
Total respiratory system compliance
Added flow resistance
Endotracheal tube
Ventilator tubings and circuits
Patient breathing pattern and ventilator setting
Tidal volume
Frequency
T_I/T_T or
End-inspiratory pause

Measurement of PEEPi

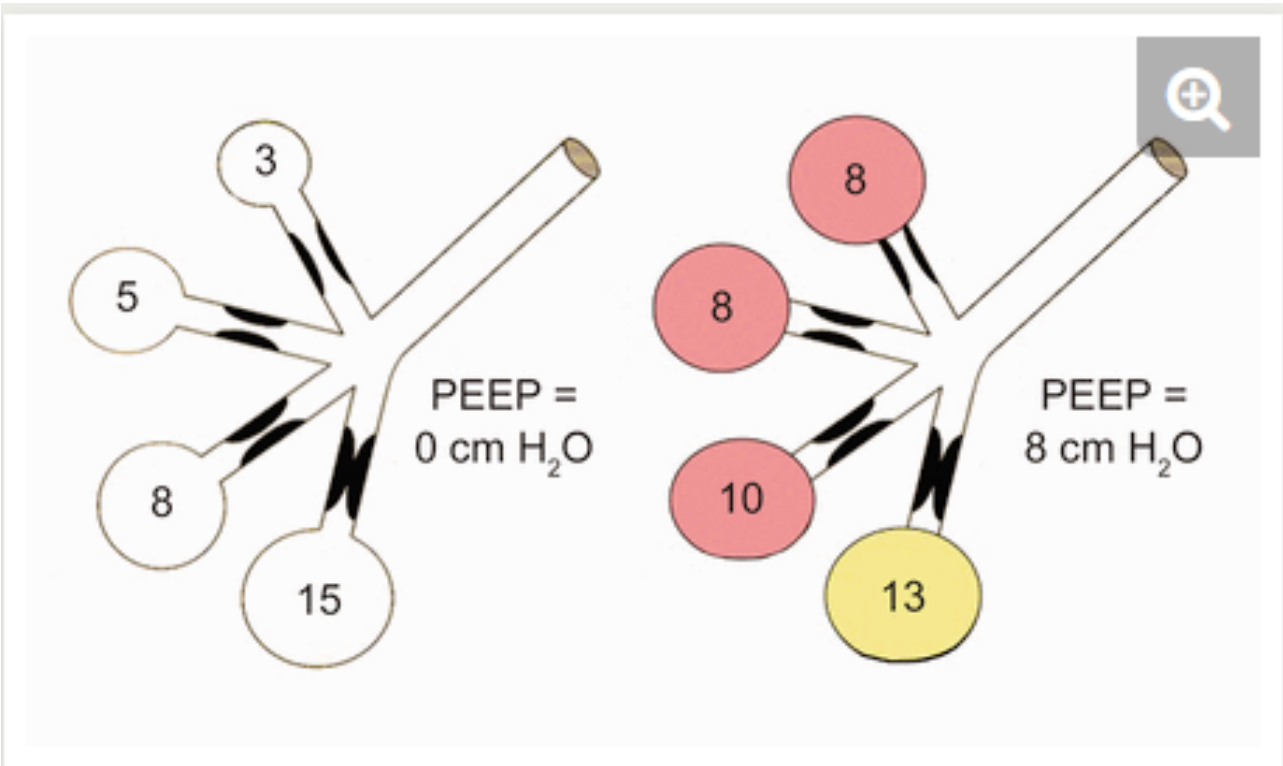
Static PEEPi



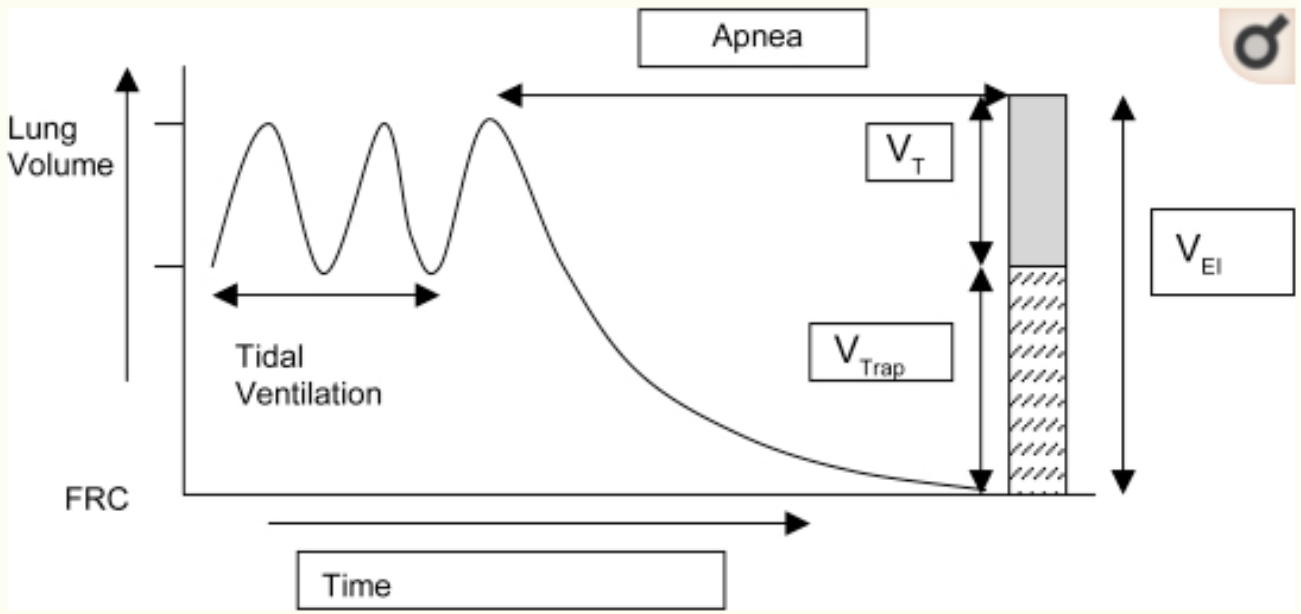
Dynamic PEEPi



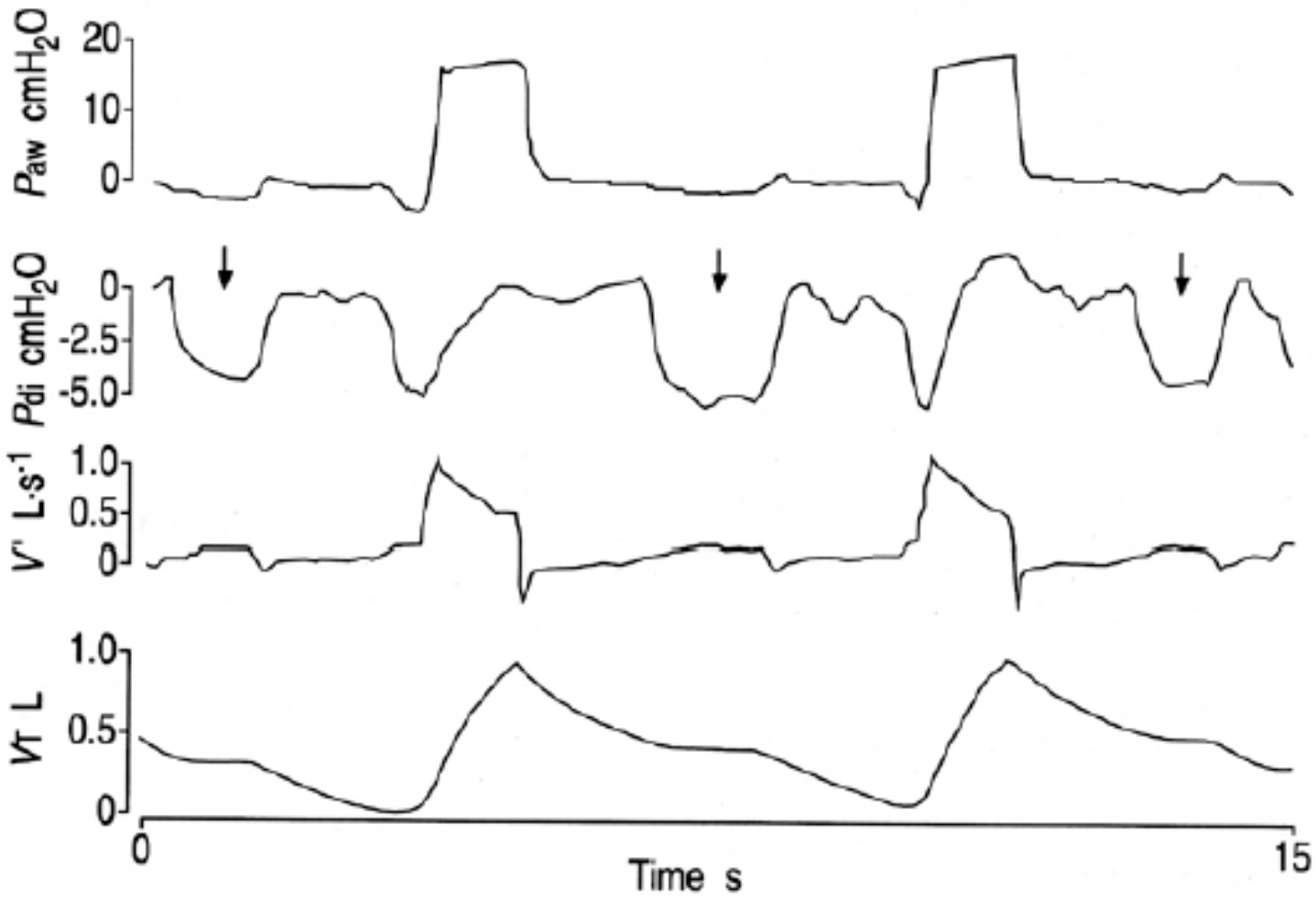
Η PEEPi είναι ανομοιογενής


3
5
8
15
PEEP =
0 cm H_2O
8
8
10
13
PEEP =
8 cm H_2O

Measurement of trapped volume


Apnea
Lung Volume
V_T
V_{EI}
V_{Trap}
Tidal Ventilation
FRC
Time

Missing efforts


P_{aw} cmH$_2$O
20
10
0
P_{di} cmH$_2$O
0
-2.5
-5.0
V' L·s^{-1}
1.0
0.5
0
V_T L
1.0
0.5
0
0
15
Time s

Στόχοι μηχανικής υποστήριξης

Table 1. Goals of Mechanical Ventilation in the Patients with COPD

① Avoid auto-PEEP
② Prevent overdistention
③ Prevent overventilation and respiratory alkalosis
④ Prevent patient-ventilator dyssynchrony
⑤ Assess for continued need for mechanical ventilation: wean and extubate when respiratory failure has resolved

Ventilator settings

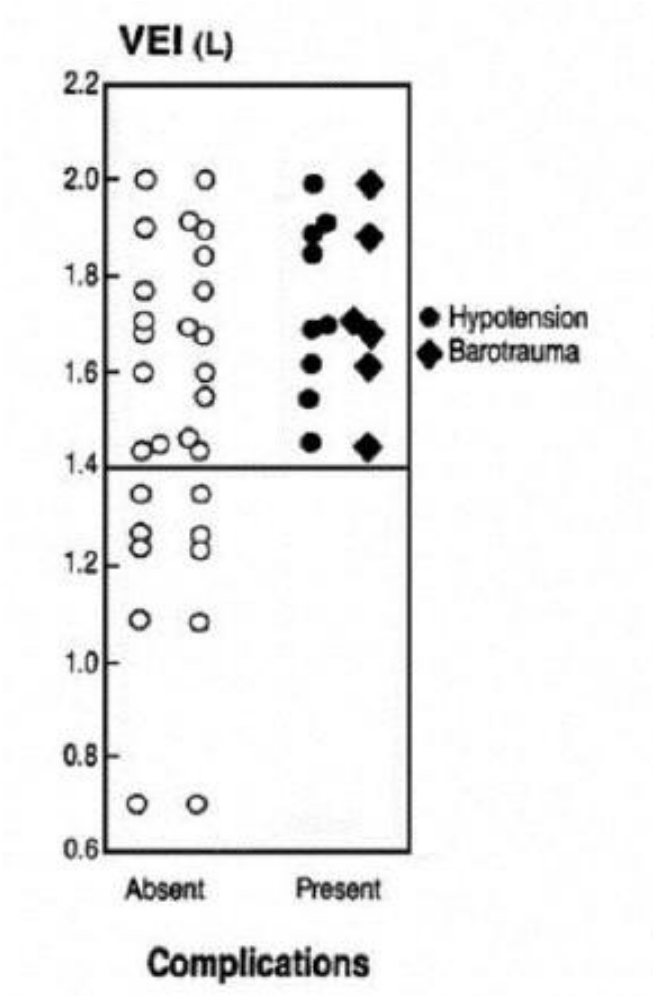
Table 3. Ventilator Setting in Patients with COPD

1. Decrease inspiratory time (30%)
2. Increase expiratory time (70%)
3. Low tidal volume (5~7 ml/kg)
4. Low respiratory rate (10~12/min)
5. High peak inspiratory flow (70~100 L/min)
6. Oxygen: Titrate so as to maintain $SaO_2 > 90\%$ and $PaO_2 > 60$ mmHg.
7. Add extrinsic PEEP up to 80% of auto-PEEP to reduce patient's work of breathing.
8. Accept hypercarbia
9. Using volume cycle assist control ventilation in the initial management of the awake COPD patient may be associated with significant risk of increase in hyperinflation and hemodynamic instability.
10. Use non-compressible tubing to minimize inspiratory time.
11. Decrease carbon dioxide load by sedation, minimizing carbohydrate load, treat hyperthermia and control infection.
12. Judicious use of sedation and muscle relaxants (when necessary) to keep the patient calm and cooperative. Agitation, "fighting ventilator" can lead to an increase in the auto-PEEP.

Complicationd during mechanical ventilation

Complications	Likely Mechanism
Hypotension	Primary: Excessive hyperinflation, sedatives
	Secondary: Pneumothorax, myocardial depression
Barotrauma	Excessive hyperinflation
Myocardial dysfunction	Primary: "Stunned myocardium" secondary to massive catecholamine release
	Secondary: Severe myocardial hypoxia/acidosis
Rhabdomyolysis	Primary: Extreme muscle exertion with or without hypoxia
	Secondary: High dose propofol
Lactic acidosis	Primary: Excessive β_2 agonists
	Secondary: Extreme muscle exertion/hypoxia
CNS injury	Primary: Cerebral anoxia secondary to respiratory arrest
	Secondary: Hypercapnia-related cerebral edema, subarachnoid hemorrhage
Acute myopathy	Glucocorticoids plus prolonged paralysis or deep sedation

Hypotension, Barotrauma



Effects of increasing the cycling-off threshold according to prolonged (A) or short (B) time constant of the respiratory system. Increasing the cycling-off threshold (CT) (Galileo Gold, Hamilton Medical, Rhäzuns, Switzerland) from 10% to 50–75% in patients with a prolonged time constant (COPD) eliminates wasted efforts. In contrast, panel B shows that increasing the cycling-off threshold (Puritan-Bennett 840, Mallinckrodt, Pleasanton, California) from 5% to 45% in patients with a short time constant (acute lung injury or acute respiratory distress syndrome) induces double-triggering or premature opening of the exhalation valve. The arrows (A) point to wasted efforts. The first arrow (B) points to double-triggering. The second arrow (B) points to premature opening of the exhalation valve. P_{aw} = airway pressure. P_{TD} = transdiaphragmatic pressure. EMG = electromyogram signal of diaphragmatic electrical activity. V_T = tidal volume. P_{es} = esophageal pressure. (Adapted from References **23** and **24**, with permission.)