Mechanical Ventilation

- It is now clear that a low–tidal volume, plateau pressure–limited ventilatory strategy reduces mortality.

- Predicted body weight is calculated based on measured height using the equations provided. This is a key point that is often overlooked by clinicians; use of actual rather than predicted body weight can result in the use of erroneously high and potentially injurious tidal volumes, particularly in female patients.

- The tidal volume should initially be set at 6 mL/kg predicted body weight. Interestingly, a tidal volume of 6 mL/kg predicted body weight is similar to normal tidal volumes in spontaneously breathing adults at rest.

- If the end-inspiratory plateau pressure (measured during a 0.5-second pause) is still >30 cm H_2O, then the tidal volume must be reduced in a stepwise fashion by 1 mL/kg to a minimum of 4 mL/kg.

- Some patients may have breath stacking or significant dyssynchrony with the ventilator.

- Increasing the inspiratory flow rate, and if necessary, the level of sedation, is usually sufficient to manage these problems.

- One randomized clinical trial showed a 28-day mortality benefit with use of neuromuscular paralysis with cisatracurium besylate for the first 48 hours in severe ARDS ($Pao_2/Fio_2 < 150$).

Predicted body weight (PBW):

Predicted BW (males) = 50 + 0.91 (cm of height − 152.4) in kg

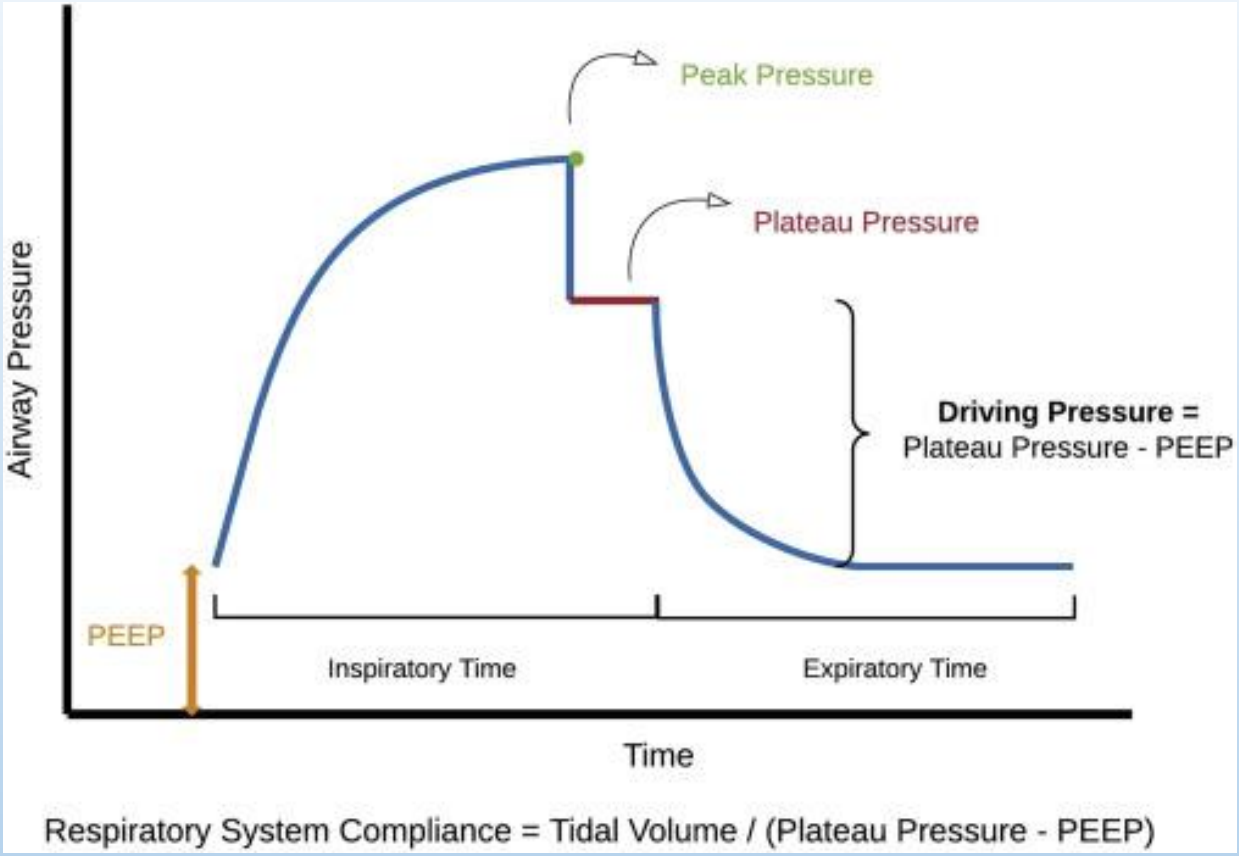
Predicted BW (females) = 45.5 + 0.91 (cm of height − 152.4) in kg

VENTILATOR MODE

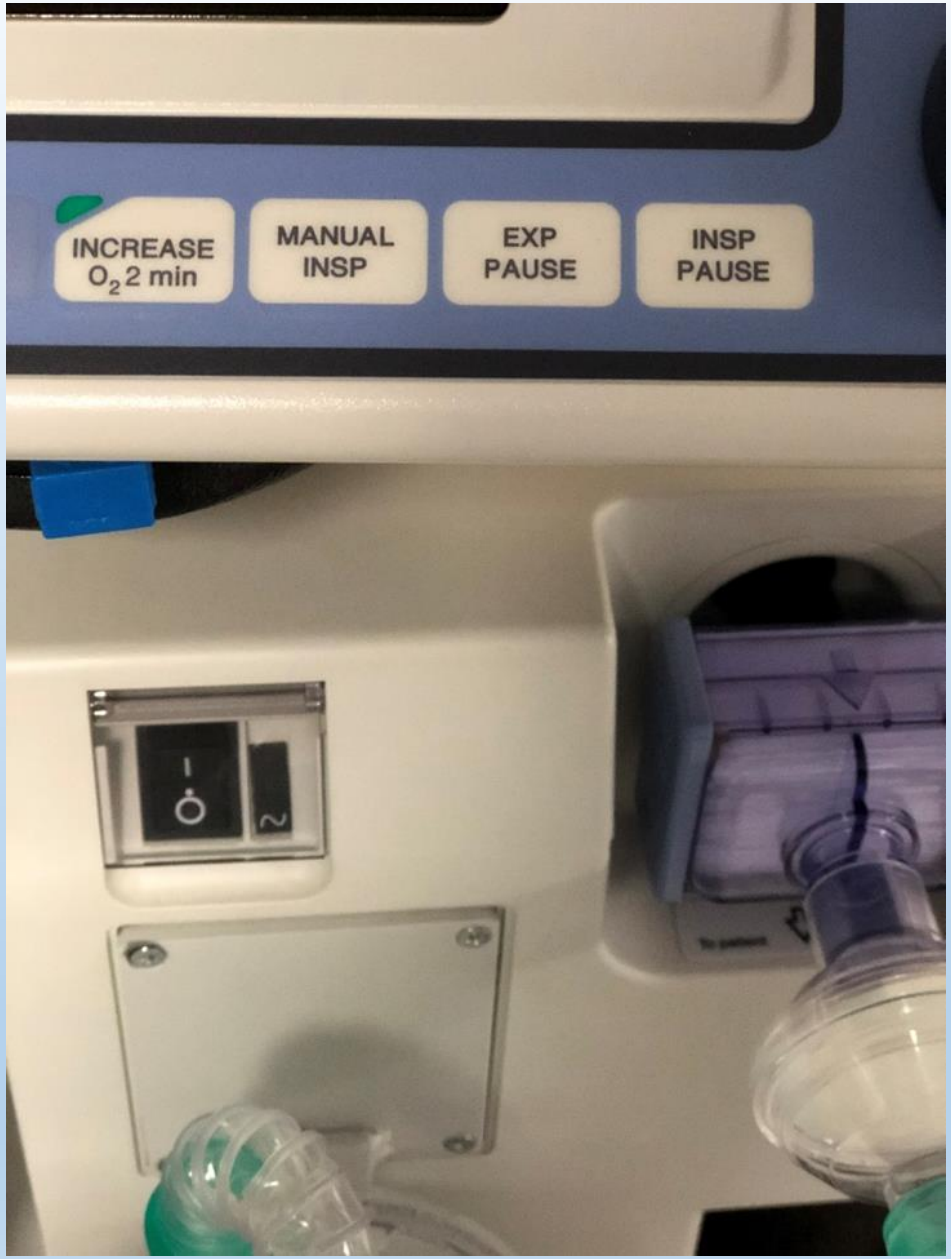
Volume Assist/Control until weaning

TIDAL VOLUME (VT)

- Initial Vt: 6 mL/kg predicted body weight
- Measure inspiratory plateau pressure (Pplat, 0.5 sec inspiratory pause) every 4 hours AND after each change in PEEP or Vt.
- If Pplat > 30 cm H2O, decrease Vt to 5 or to 4 mL/kg.
- If Pplat < 25 cm H20 and Vt < 6 mL/kg PBW

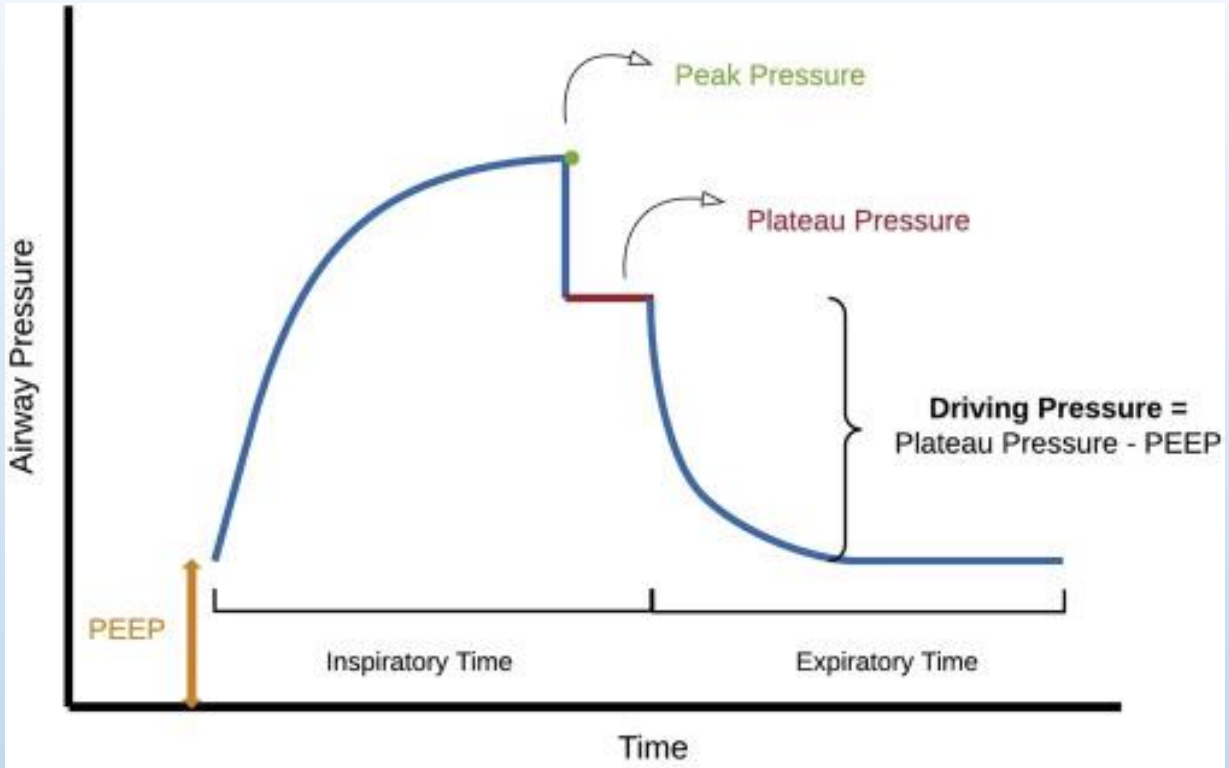


Respiratory System Compliance = Tidal Volume / (Plateau Pressure - PEEP)


INCREASE
O_2 2 min
MANUAL
INSP
EXP
PAUSE
INSP
PAUSE
I
O
2

$$\text{Driving Pressure} = \frac{V_T}{C_{ST}}$$

$$\text{Driving Pressure} = P_{plat} - PEEP$$



Respiratory System Compliance = Tidal Volume / (Plateau Pressure - PEEP)

RESPIRATORY RATE (RR)

- With initial change in Vt, adjust RR to maintain minute ventilation.
- Make subsequent adjustments to RR to maintain pH 7.30-7.45, but do not exceed RR = 35/min and do not increase set rate if $PaCO_2 < 25$ mm Hg.

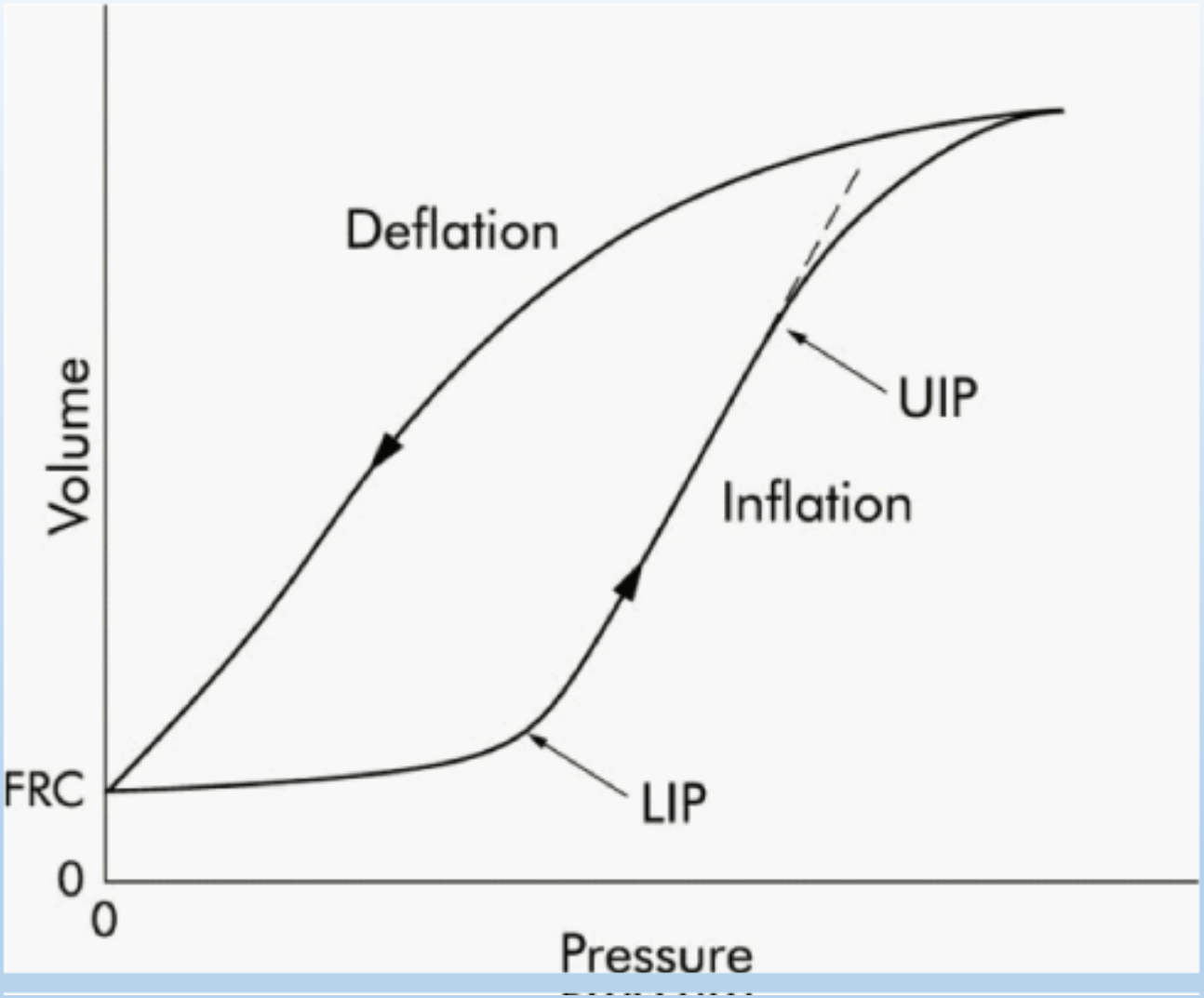
I : E Ratio

Acceptable range, 1:1-1:3 (no inverse ratio)

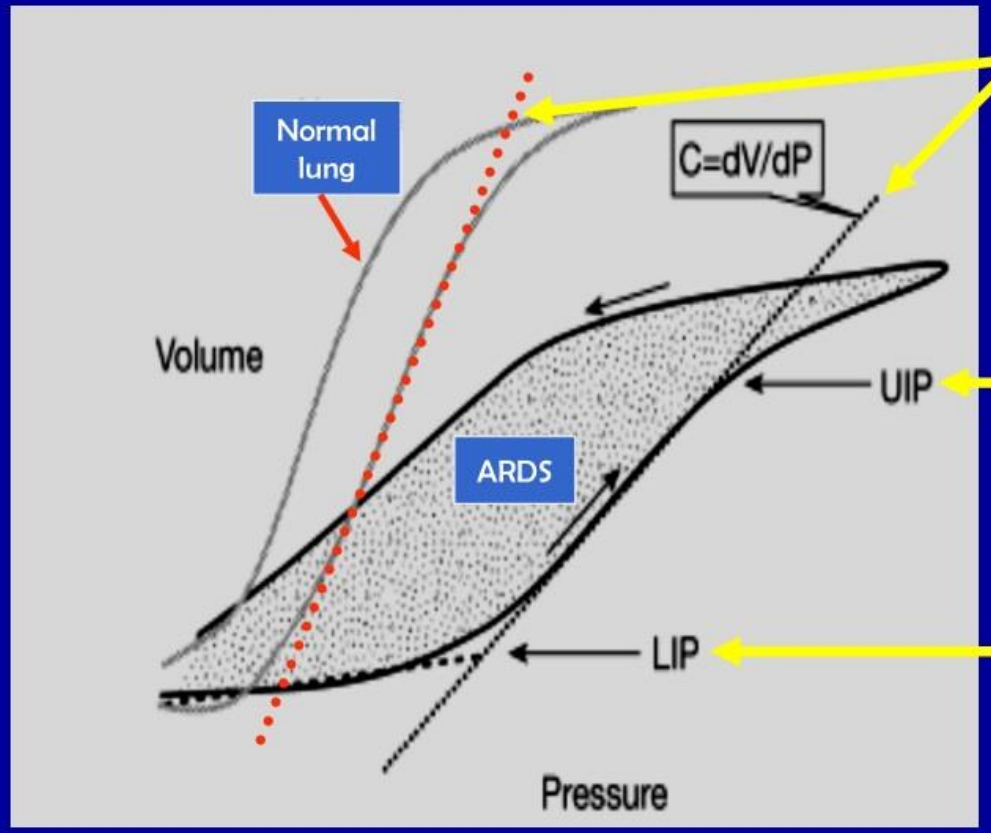
FIO2, PEEP, AND ARTERIAL OXYGENATION

Maintain PaO2 = 55-80 mm Hg or SpO2 = 88%-95% using the following PEEP/FiO2 combinations:

Low PEEP						
FiO_2	0.3-0.4	0.4-0.5	0.5-0.7	0.7-0.8	0.8-0.9	1.0
PEEP (cm H_2O)	5-8	8-10	10-12	14	16-18	18-24
High PEEP						
FiO_2	0.3-0.4	0.5	0.5-0.8	0.8	0.9	1.0
PEEP (cm H_2O)	5-16	16-18	20	22	22	22-24


Deflation
UIP
Inflation
LIP
Volume
FRC
0
0
Pressure

The pressure-volume loop can tell us a lot about lung physiology!



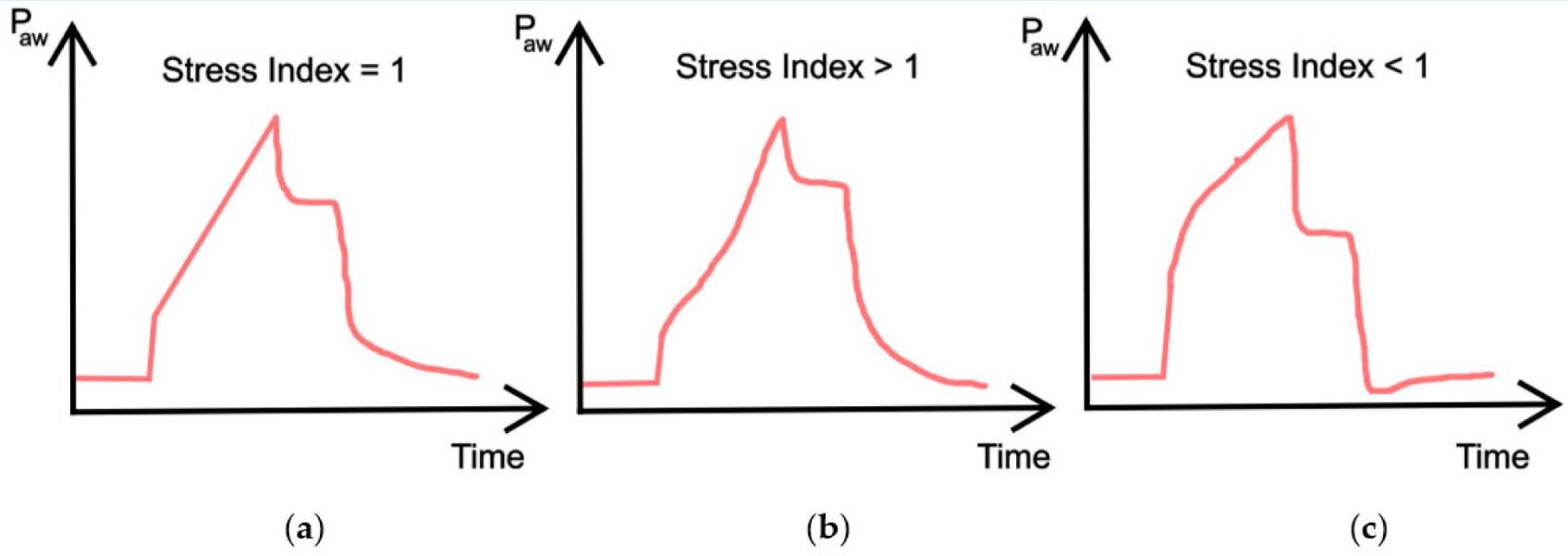
Compliance (C)
is markedly reduced in the injured lung on the right as compared to the normal lung on the left

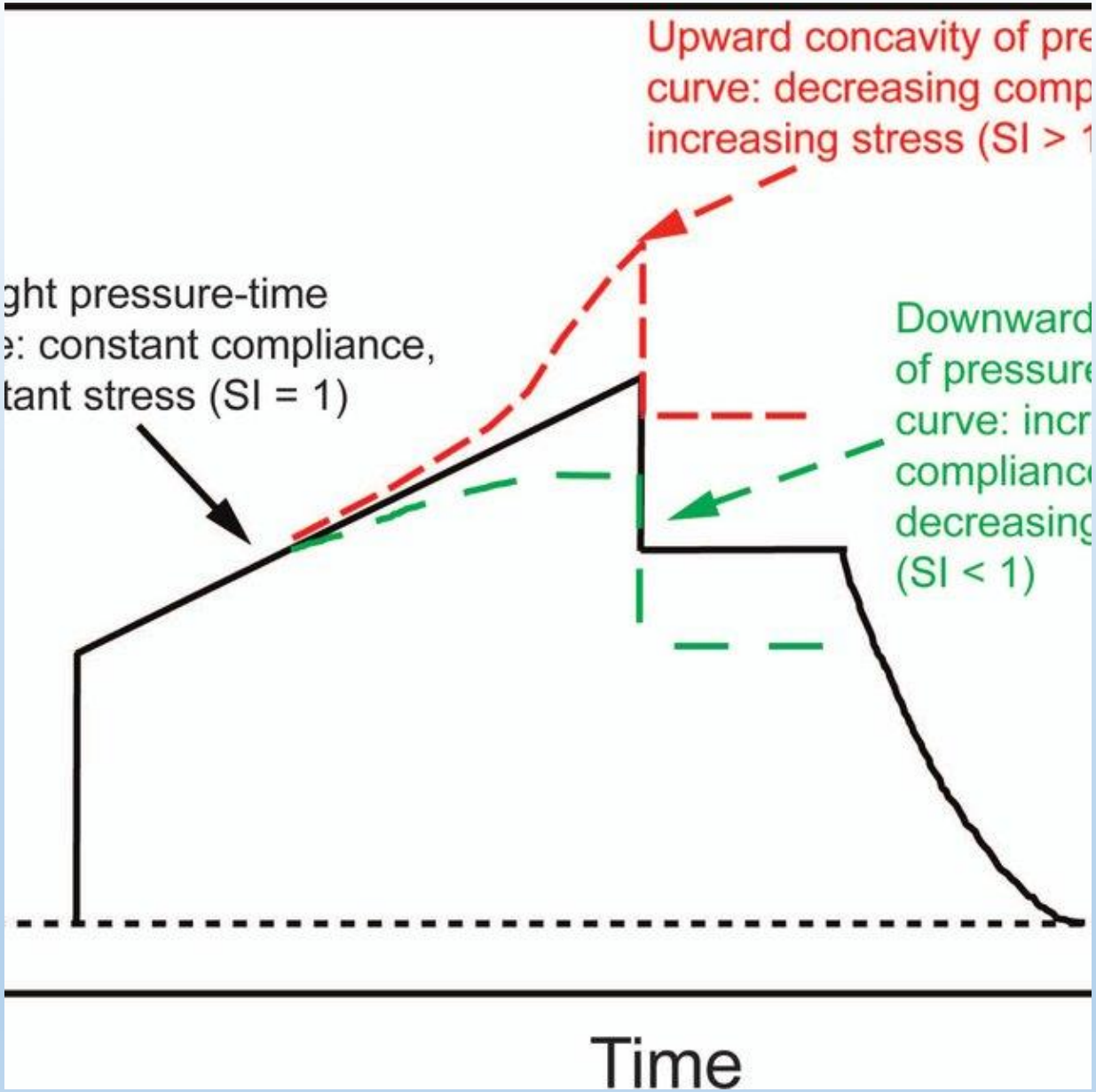
Upper inflection point (UIP)
above this pressure, additional alveolar recruitment requires disproportionate increases in applied airway pressure

Lower inflection point (LIP)
Can be thought of as the minimum baseline pressure (PEEP) needed for optimal alveolar recruitment

I. de Chazal and R. D. Hubmayr

British Journal of Anaesthesia **91** (1): 81–91 (2003)


Paw
Stress Index = 1
Time
(a)
Paw
Stress Index > 1
Time
(b)
Paw
Stress Index < 1
Time
(c)


Upward concavity of pre
curve: decreasing comp
increasing stress (SI > 1
ght pressure-time
e: constant compliance,
tant stress (SI = 1)
Downward
of pressure
curve: incr
compliance
decreasing
(SI < 1)
Time

ACIDOSIS MANAGEMENT

- If pH < 7.30, increase RR until pH ≥ 7.30 or RR = 35/min.
- If pH remains <7.30 with RR = 35, consider bicarbonate infusion.
- If pH < 7.15, Vt may be increased (Pplat may exceed 30 cm H2O).

ALKALOSIS MANAGEMENT

If pH > 7.45 and patient not triggering ventilator, decrease set RR but not below 6/min.

FLUID MANAGEMENT

- Once patients are out of shock adopt a conservative fluid management strategy.
- Use diuretics or fluids to target a central venous pressure (CVP) of <4 or a pulmonary artery occlusion pressure (PAOP) of <8.

LIBERATION FROM MECHANICAL VENTILATION

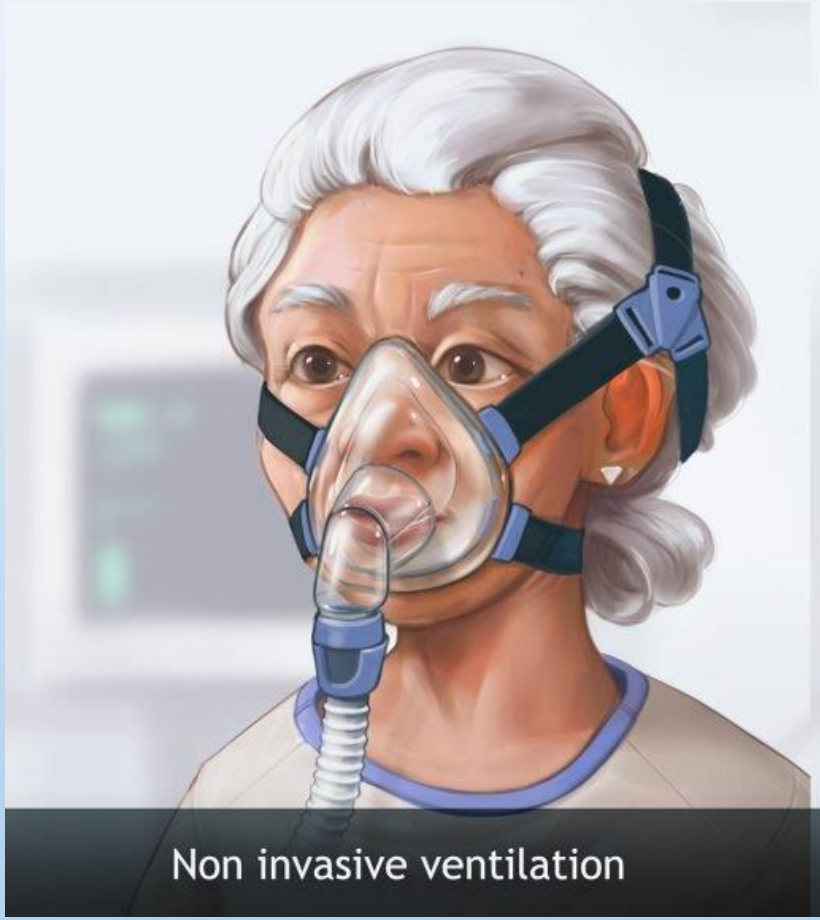
- Daily interruption of sedation
- Daily screen for spontaneous breathing trial (SBT)
- SBT when all of the following criteria are present:

(a) $FiO_2 < 0.40$ and PEEP < 8 cm H_2O
(b) Not receiving neuromuscular blocking agents
(c) Patient is awake and following commands.
(d) Systolic arterial pressure > 90 mm Hg without vasopressor support
(e) Tracheal secretions are minimal, and the patient has a good cough and gag reflex.

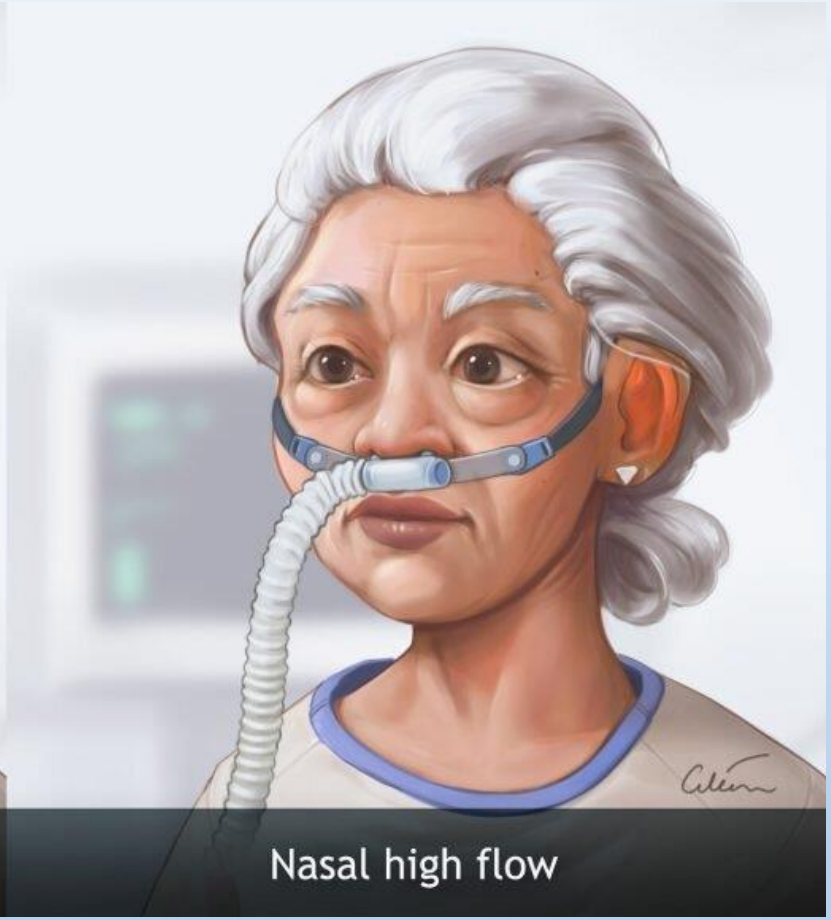
SPONTANEOUS BREATHING TRIAL

- Place patient on 5 mm Hg pressure support with 5 mm Hg PEEP or T-piece.
- Monitor HR, RR, oxygen saturation for 30-90 minutes.
- Extubate if there are no signs of distress (tachycardia, tachypnea, agitation, hypoxia, diaphoresis).

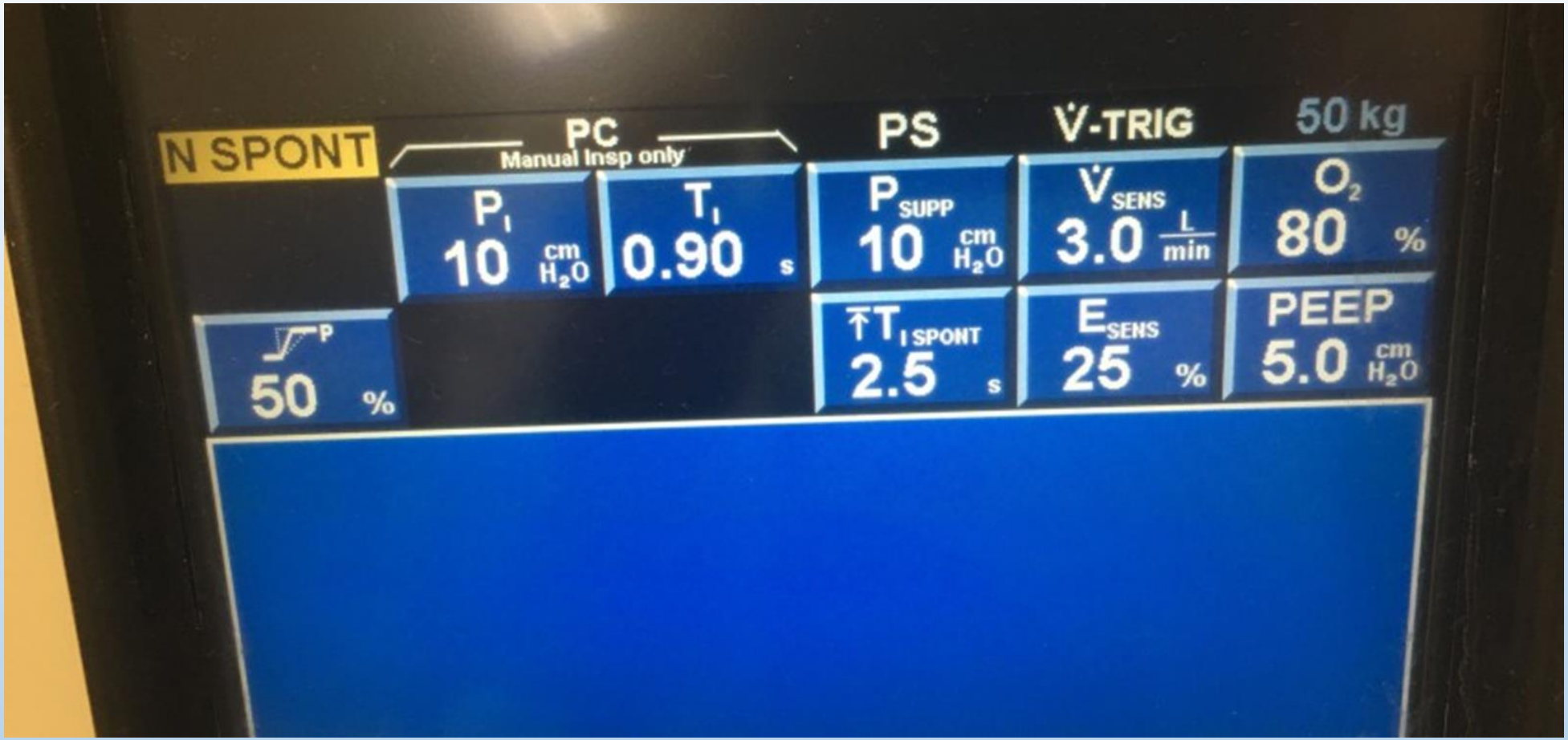
Pending data from larger randomized clinical studies, a trial of noninvasive mechanical ventilation or high-flow nasal cannula oxygen could be considered in a patient with ARDS who does not have a severe oxygenation defect, hemodynamic instability, or altered mental status as long as the patient can be closely observed and readily intubated if needed.

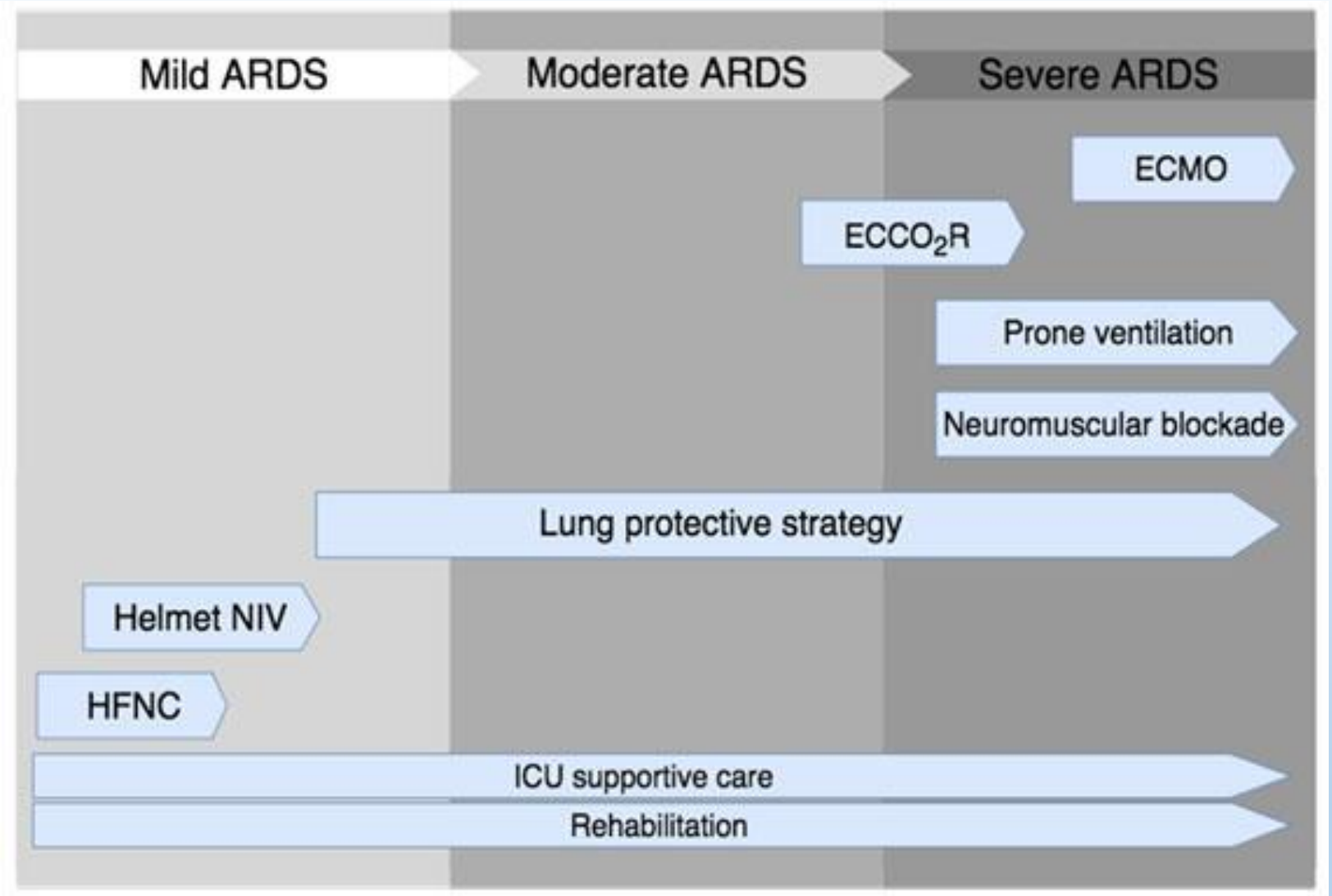


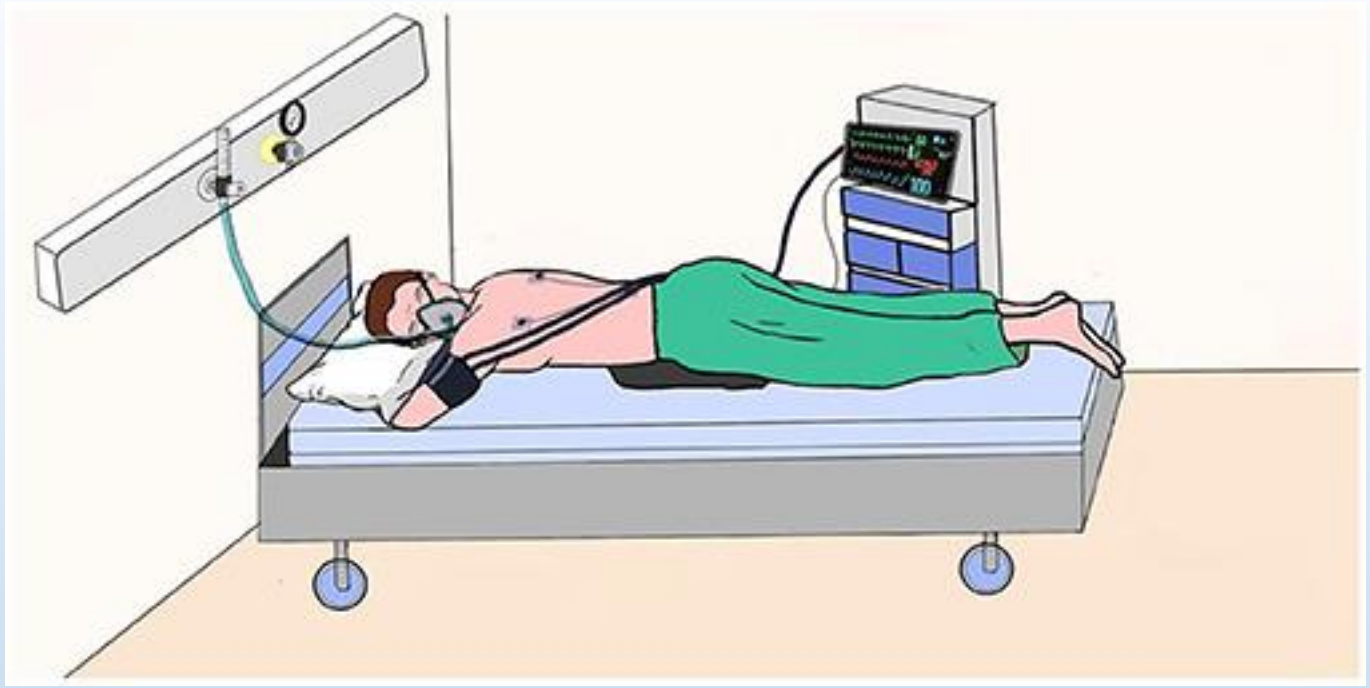
Non invasive ventilation



Nasal high flow


N SPONT
PC
Manual Insp only
PS
V̇-TRIG
50 kg
P_I
10 cm H2O
T_I
0.90 s
P_SUPP
10 cm H2O
V̇_SENS
3.0 L/min
O2
80 %
P
50 %
T̈T_I SPONT
2.5 s
E_SENS
25 %
PEEP
5.0 cm H2O


Mild ARDS
Moderate ARDS
Severe ARDS
ECMO
ECCO2R
Prone ventilation
Neuromuscular blockade
Lung protective strategy
Helmet NIV
HFNC
ICU supportive care
Rehabilitation



Prone
Positioning

Although prone positioning improved oxygenation, there was no mortality benefit
Patients were randomized according to severity of hypoxemia to receive 20 hours of prone positioning vs. usual care and had no reduction in mortality at 28 days or 6 months.
Patients with more severe ARDS (PaO_2/FiO_2 < 150 mm Hg) were randomized to supine or prone position (>16 h/day). Patients in the prone group had improved 28-day mortality.


thank you
danke
謝謝
ngiyabonga
شكراً جزيلاً
teşekkür ederim
спасибо
dank je
gracias
tapadh leat
mochchakkeram
dziękuję
bedankt
go raibh maith agat
obrigado
sukriya
kop khun krap
arigatō
dakujem
grazie
merci
мерси
감사합니다