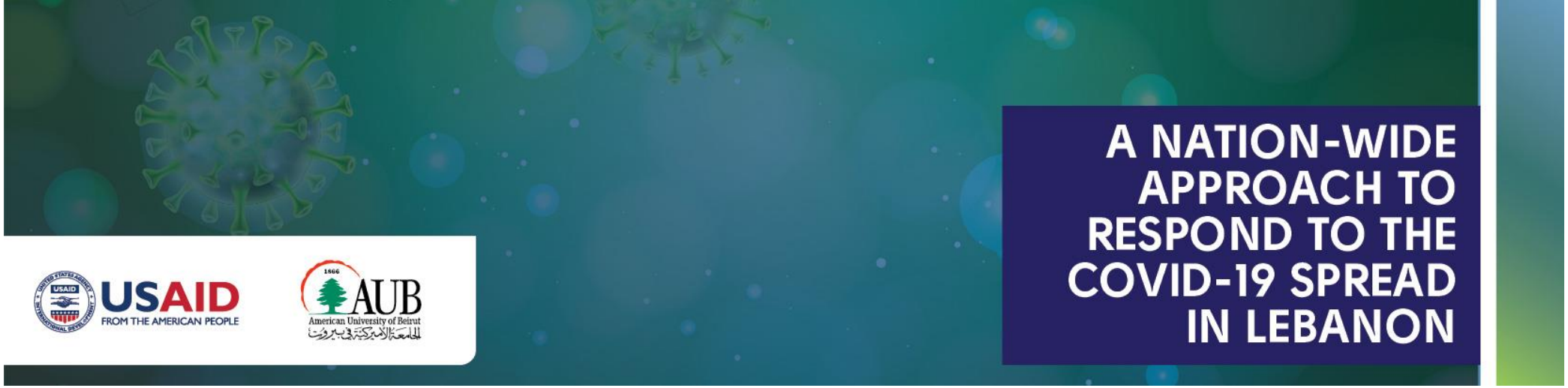


Management of intubated patients

When to Intubate your Patient?

- If refractory or no improving hypoxemia. *(PaO2 <60 and SpO2 < 90%).*
- If severe respiratory distress (RR>35), with accessory muscle use.
- If contraindicated or not improving on non-invasive methods and self-pronation.
- If hemodynamic instability or decrease level of consciousness.
- **Note:** Early intubation is recommended if deterioration in respiratory failure is anticipated. *Take into account the delays that occur in intubation.*
- *To consider in prolonged dependence on BiPAP*

Preparation for Intubation

- Maintain high flow nasal cannula or BIPAP until intubation team arrives.
- Ensure intubation equipment is present: *video and direct laryngoscope, stylets, bougies, ETT tubes with several sizes, suction catheter, airway, bag-mask valve with viral filter, ventilation machine, stethoscope, 10cc syringe, tube holder, etc…*
- Prepare fluids and norepinephrine in case of low or borderline blood pressure.
- Note that intubation **must be** performed by the **most experienced physician = Anesthesia team.**

Post-Intubation Management

- Insert NG tube.
- Insert Central line and arterial line.
- Obtain a CXR.
- Obtain ABGs one hour after initial settings.
- Insert foley catheter for accurate I/O.
- In case of hypotension post-induction, give 500-1000mL of NSS bolus. If patient remains hypotensive start norepinephrine.
- Start sedation: *(target RASS -3 or -4)*
  - Analgesia: Fentanyl or remifentanil as per protocol.
  - Sedative: Propofol or midazolam as per protocol. *(double agents may be needed).*

Initial settings on Mechanical Ventilator

- AC – VC or VC+ mode.
- Tidal volume: Vt 4-6mL/kg of ideal body weight IBW *(Use online calculator to obtain IBW, calculated from height).*
- PEEP: 5-10 cmH2O. Depends on the level of support the patient was on.
- FiO2: 100%.
- Respiratory rate: 18-24.
- I to E ratio: set Ti to have initial ratio at 1:1.
- Peak pressure <35 and Pplat <30.

Table 3. The Berlin Definition of Acute Respiratory Distress Syndrome

	Acute Respiratory Distress Syndrome
Timing	Within 1 week of a known clinical insult or new or worsening respiratory symptoms
Chest imaging[a]	Bilateral opacities—not fully explained by effusions, lobar/lung collapse, or nodules
Origin of edema	Respiratory failure not fully explained by cardiac failure or fluid overload Need objective assessment (eg, echocardiography) to exclude hydrostatic edema if no risk factor present
Oxygenation[b]	
Mild	200 mm Hg < Pao_2/Fio_2 ≤ 300 mm Hg with PEEP or CPAP ≥5 cm H_2O[c]
Moderate	100 mm Hg < Pao_2/Fio_2 ≤ 200 mm Hg with PEEP ≥5 cm H_2O
Severe	Pao_2/Fio_2 ≤ 100 mm Hg with PEEP ≥5 cm H_2O

Abbreviations: CPAP, continuous positive airway pressure; Fio_2, fraction of inspired oxygen; Pao_2, partial pressure of arterial oxygen; PEEP, positive end-expiratory pressure.

[a] Chest radiograph or computed tomography scan.

[b] If altitude is higher than 1000 m, the correction factor should be calculated as follows: [Pao_2/Fio_2 × (barometric pressure/760)].

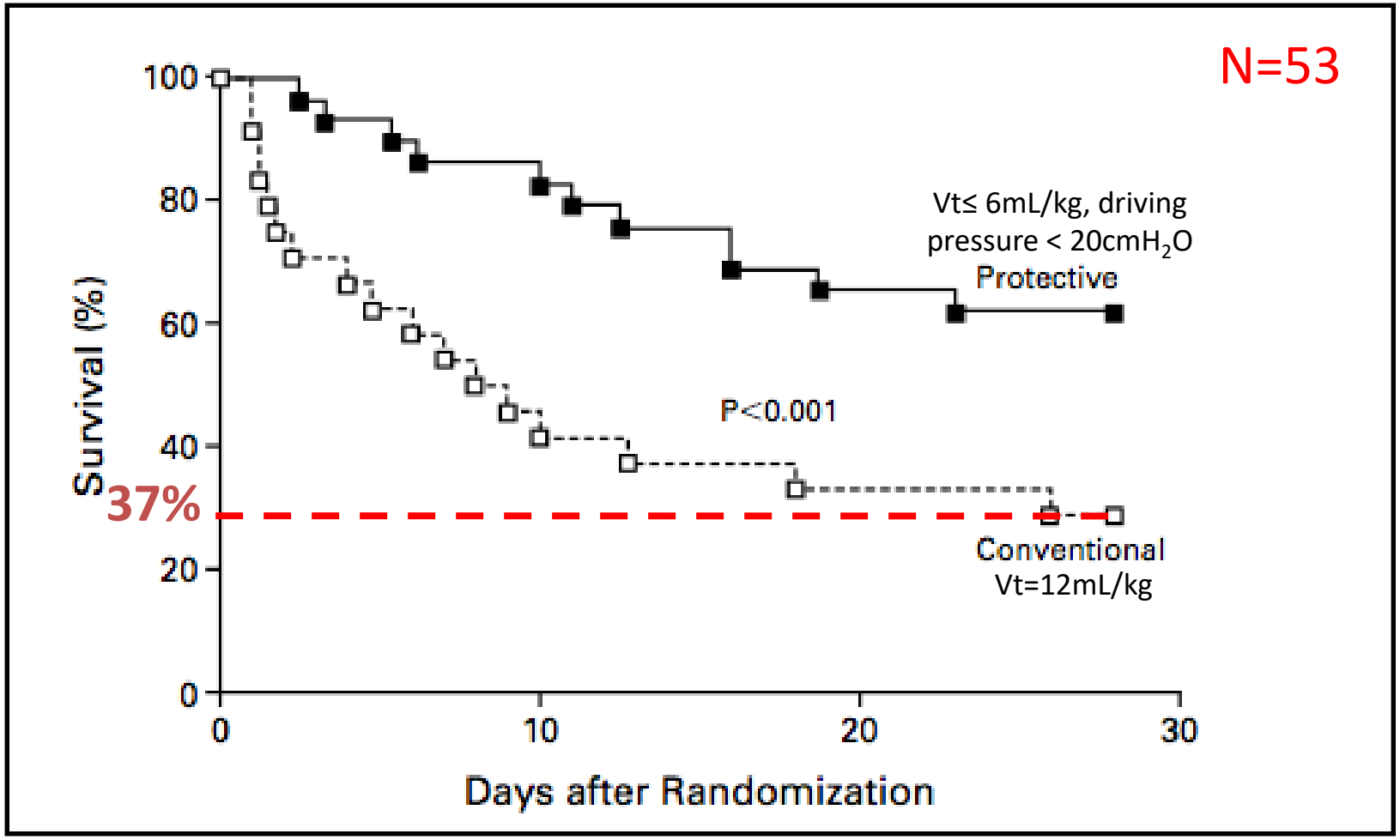
[c] This may be delivered noninvasively in the mild acute respiratory distress syndrome group.

Low tidal volume ventilation

EFFECT OF A PROTECTIVE-VENTILATION STRATEGY ON MORTALITY IN THE ACUTE RESPIRATORY DISTRESS SYNDROME

MARCELO BRITTO PASSOS AMATO, M.D., CARMEN SILVIA VALENTE BARBAS, M.D., DENISE MACHADO MEDEIROS, M.D., RICARDO BORGES MAGALDI, M.D., GUILHERME DE PAULA PINTO SCHETTINO, M.D., GERALDO LORENZI-FILHO, M.D., RONALDO ADIB KAIRALLA, M.D., DANIEL DEHEINZELIN, M.D., CARLOS MUNOZ, M.D., ROSELAINE OLIVEIRA, M.D., TERESA YAE TAKAGAKI, M.D., AND CARLOS ROBERTO RIBEIRO CARVALHO, M.D.

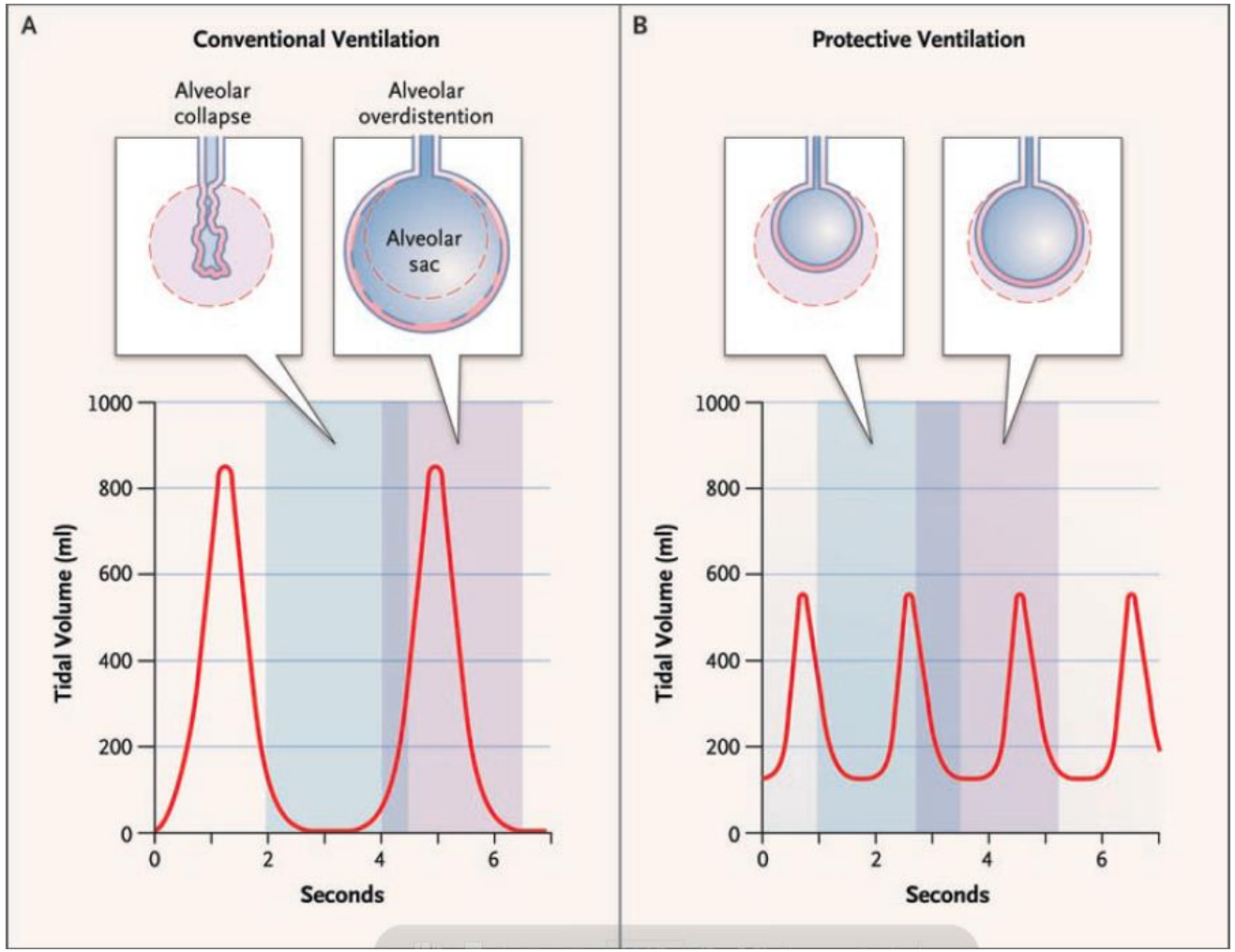
NEJM, 1998



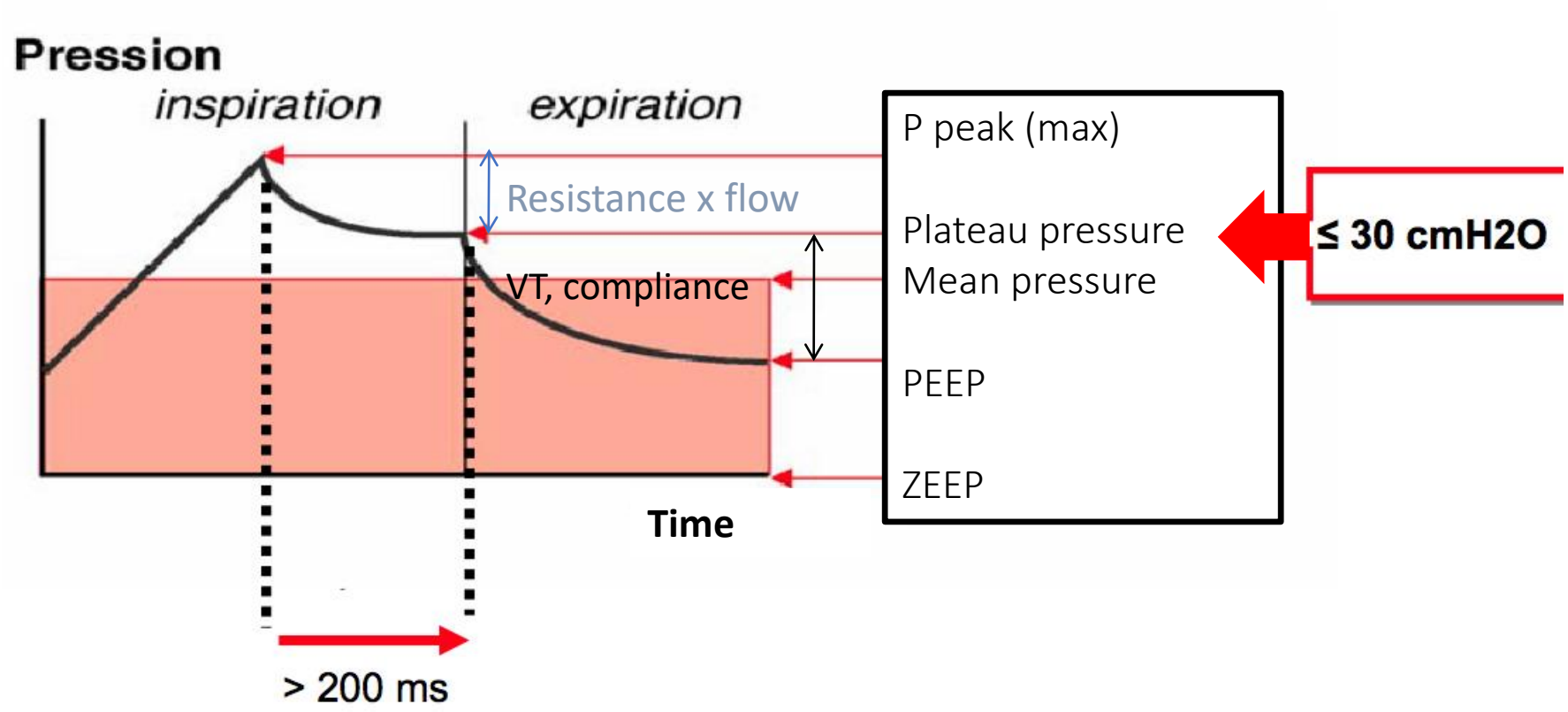
Low-Tidal-Volume Ventilation in the Acute Respiratory Distress Syndrome

Atul Malhotra, M.D.

NEJM 2007



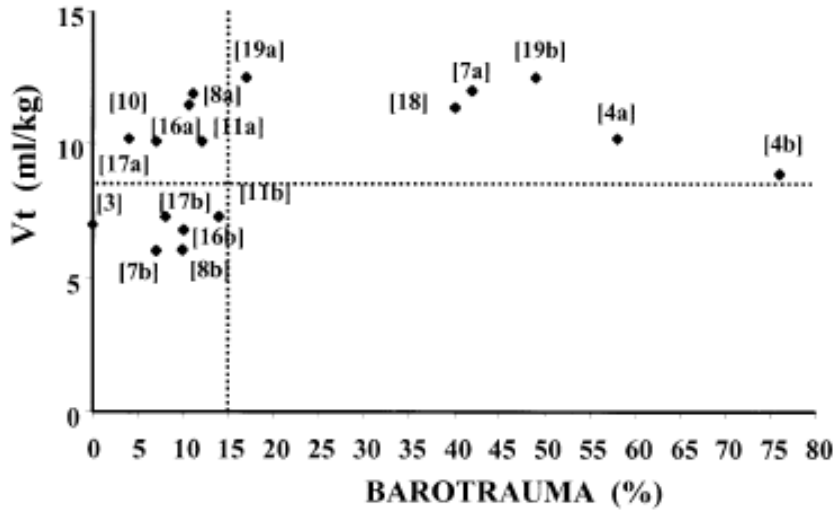
Limit the plateau pressure

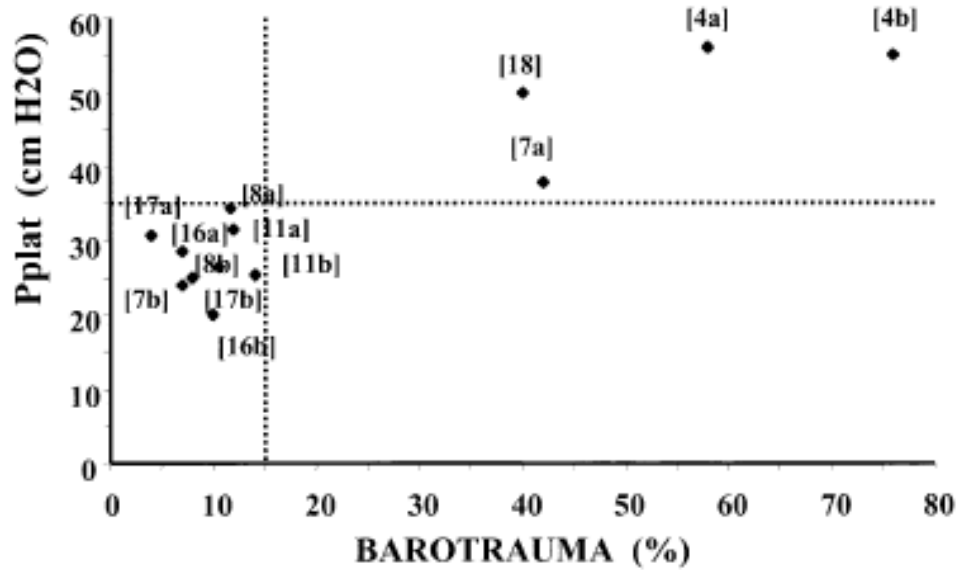

Pression
inspiration
expiration
Resistance x flow
VT, compliance
Time
> 200 ms
P peak (max)
Plateau pressure
Mean pressure
PEEP
ZEEP
≤ 30 cmH2O

Mohamed Boussarsar
Guillaume Thierry
Samir Jaber
Françoise Roudot-Thoraval
François Lemaire
Laurent Brochard

Relationship between ventilatory settings and barotrauma in the acute respiratory distress syndrome

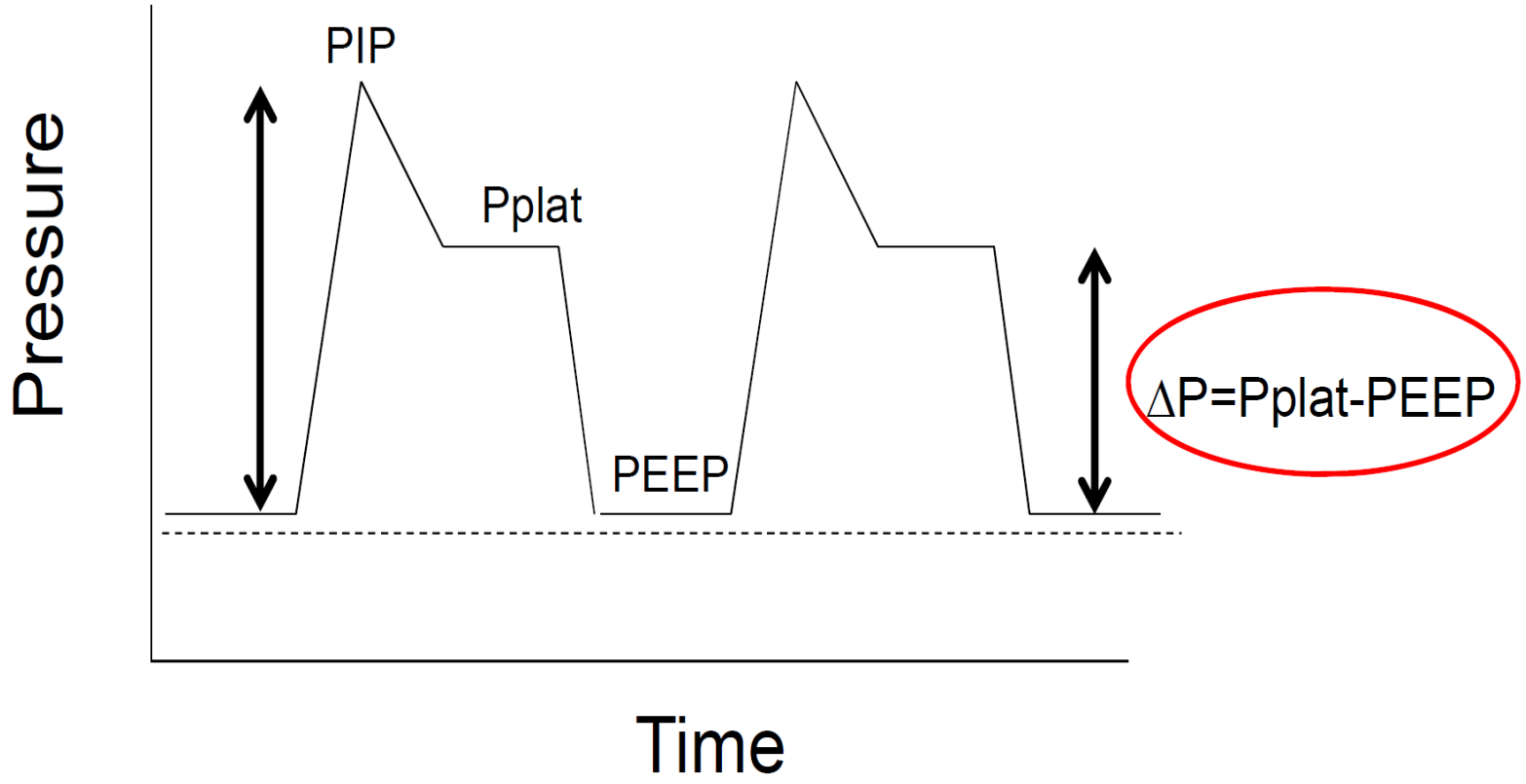
Intensive Care Med (2002)





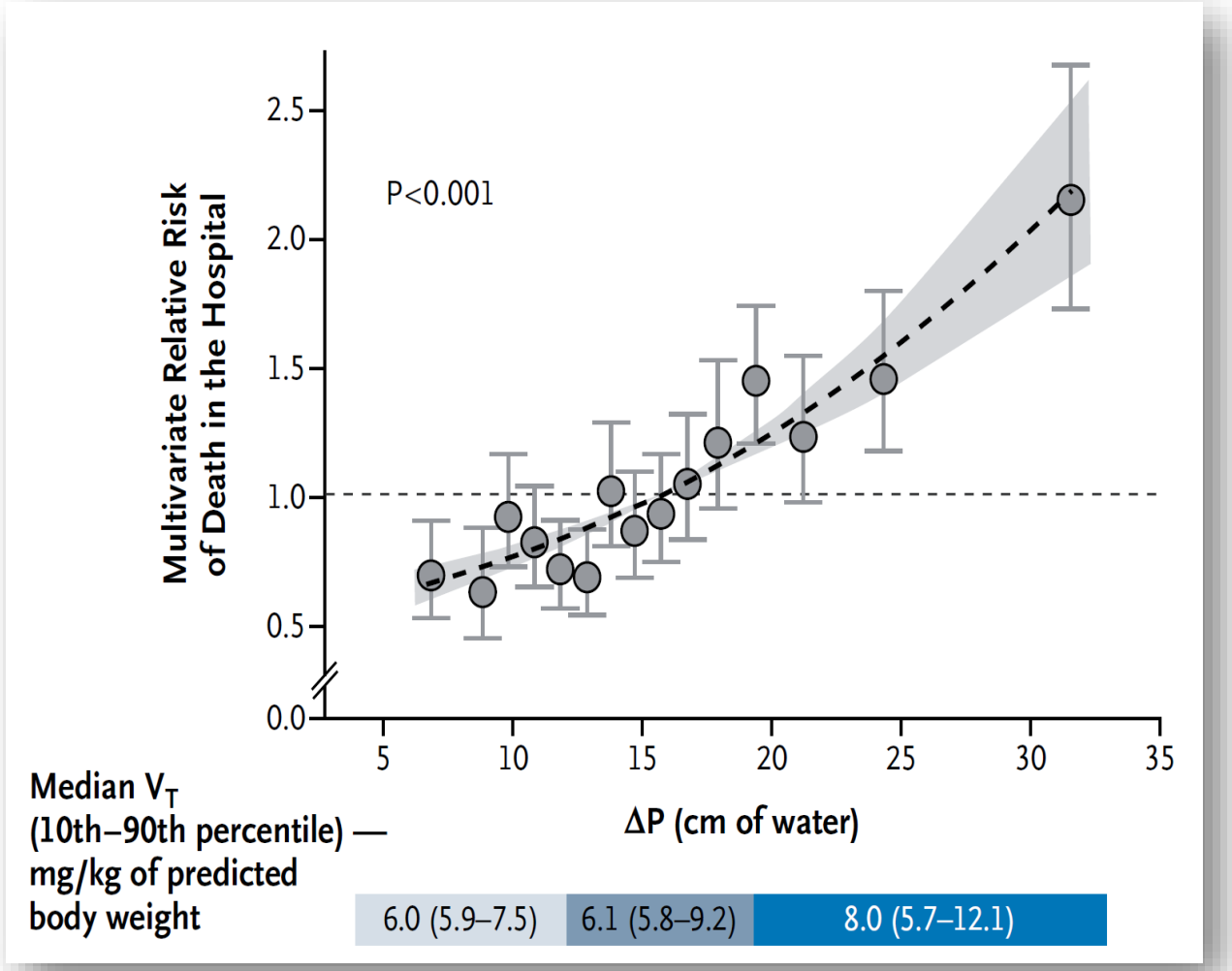
Limit the driving pressure

Driving pressure



N ENGL J MED 372;8 NEJM.ORG FEBRUARY 19, 2015

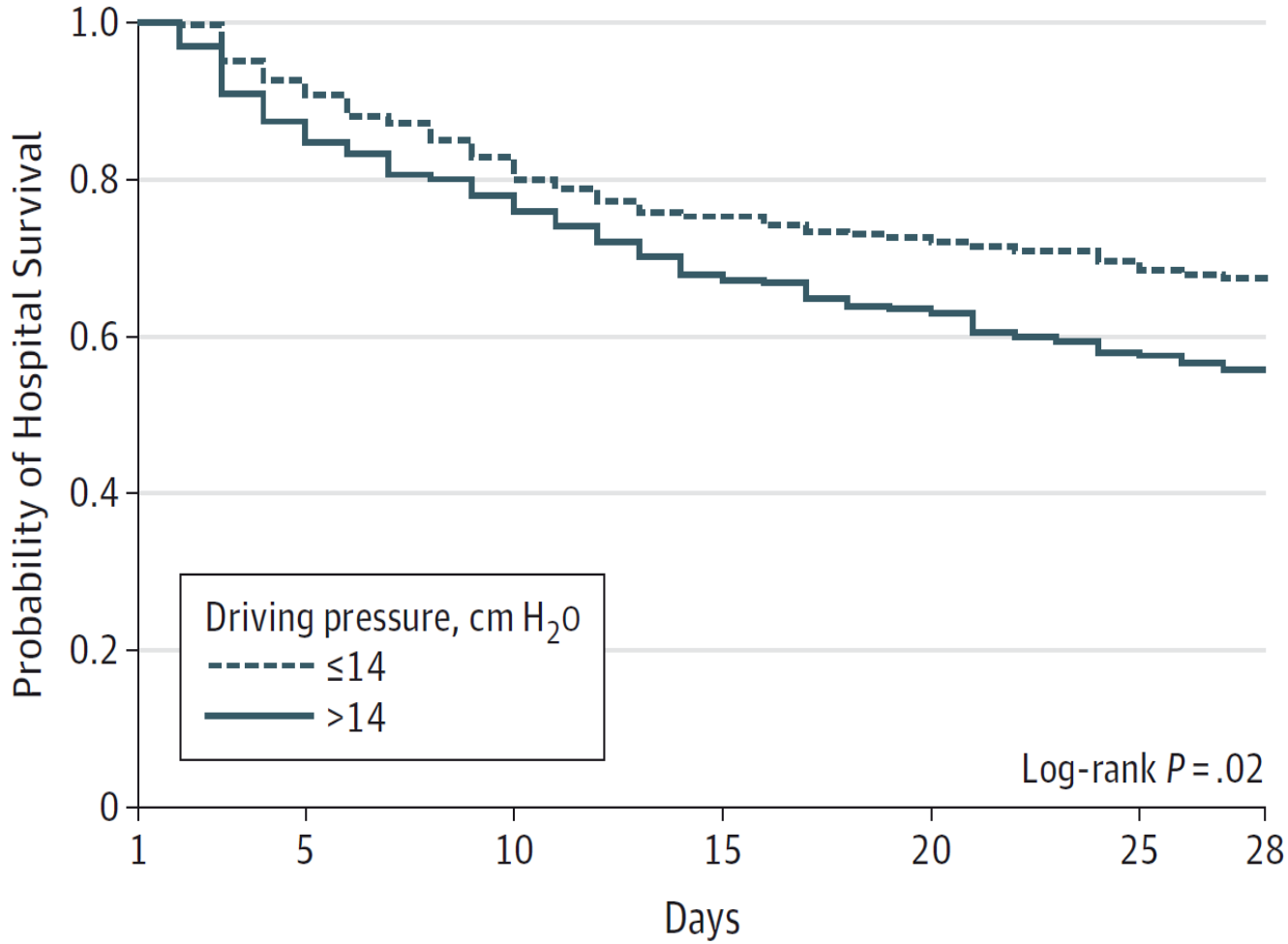
Driving Pressure and Survival in the Acute Respiratory Distress Syndrome



Epidemiology, Patterns of Care, and Mortality for Patients With Acute Respiratory Distress Syndrome in Intensive Care Units in 50 Countries

JAMA. 2016;315(8):788-800.

C Probability of hospital survival by driving pressure



High vs Low PEEP

Higher vs Lower Positive End-Expiratory Pressure in Patients With Acute Lung Injury and Acute Respiratory Distress Syndrome

Systematic Review and Meta-analysis

JAMA. 2010;303(9):865-873

Characteristic	Trial		
	ALVEOLI,[8] 2004	LOVS,[9] 2008	EXPRESS,[10] 2008
Inclusion criteria	Acute lung injury with PaO_2:FIO_2 ≤300[a]	Acute lung injury with PaO_2:FIO_2 ≤250[a]	Acute lung injury with PaO_2:FIO_2 ≤300[a]
Recruitment period	1999-2002	2000-2006	2002-2005
Recruiting hospitals (country)	23 (United States)	30 (Canada, Australia, Saudi Arabia)	37 (France)
Patients randomized to higher vs lower PEEP	276 vs 273	476 vs 509[b]	385 vs 383[c]
Validity			
Concealed allocation	Yes	Yes	Yes
Follow-up for primary outcome, %	100	100	100
Blinded data analysis	Yes	Yes	Yes
Stopped early	Stopped for perceived futility	No	Stopped for perceived futility
Experimental intervention	Higher PEEP according to FIO_2 chart, recruitment maneuvers for first 80 patients	Higher PEEP according to FIO_2 chart, required plateau pressures ≤40 cm H_2O, recruitment maneuvers	PEEP as high as possible without increasing the maximum inspiratory plateau pressure >28-30 cm H_2O
Control intervention	Conventional PEEP according to FIO_2 chart, required plateau pressures ≤30 cm H_2O, no recruitment maneuvers	Conventional PEEP according to FIO_2 chart, required plateau pressures ≤30 cm H_2O, no recruitment maneuvers	Conventional PEEP (5-9 cm H_2O) to meet oxygenation goals
Ventilator procedures	Target tidal volumes of 6 mL/kg of predicted body weight; plateau pressures ≤30 cm H_2O (with exception as above); respiratory rate ≤35/min, adjusted to achieve arterial pH 7.30-7.45; ventilator mode: volume-assist control (except higher PEEP group in LOVS required pressure control); oxygenation goals: PaO_2 55-80 mm Hg and SPO_2 88%-95%; standardized weaning)		

Abbreviations: ALVEOLI, Assessment of Low Tidal Volume and Elevated End-Expiratory Pressure to Obviate Lung Injury; EXPRESS, Expiratory Pressure Study; FIO_2, fraction of inspired oxygen; LOVS, Lung Open Ventilation to Decrease Mortality in the Acute Respiratory Distress Syndrome; PEEP, positive end-expiratory pressure; SPO_2, oxygen saturation.

[a] Acute lung injury defined according to the American-European Consensus Conference.[12]

[b] Includes 2 patients for whom consent was withdrawn prior to protocol initiation, without patient, family, and caregivers being aware of group assignment (ie, 983 patients analyzed).

[c] Includes 1 patient for whom consent was withdrawn prior to protocol initiation, without patient, family, and caregiver awareness of assignment (ie, 767 patients included in the analysis).

My Patient is still Hypoxic.. What to Do?

Non-Ventilatory Adjustments:

- Conservative fluid management: Diuresis plan monitored by I/O, hemodynamics, and creatinine.
- Increase sedation to target RASS -5 (unarousable) in case of ventilator-patient dyssynchrony.
- Initiate paralysis by rocuronium or cisatracurium pushes or infusions, when there is persistent vent dyssynchrony.

Early Neuromuscular Blockade in the Acute Respiratory Distress Syndrome-

- 340, with P/fio2 <150 randomised for early continuous infusion of cisatracurium vs usual care. NEJM 2016
  - Cisatracurium improved survival
- 1006, with P/fio2 <150 randomised for early continuous infusion of cisatracurium vs usual care. NEJM 2019
  - Stopped early. No benefit.

My Patient is still Hypoxic.. What to Do?

Ventilatory Adjustments for Refractory hypoxemia

- **Tidal Volume management:** when Pplat >30, ↓ Vt to 4mL/kg IBW, expect to have hypercarbia, ↑RR as needed to compensate and monitor for auto-PEEP.
- **PEEP/fiO2 management:**
  Use the ARDSnet lower PEEP/Higher FiO2 scale to target SpO2 88-95% and PaO2 >55-80 mmHg.

Lower PEEP/higher FiO2

FiO_2	0.3	0.4	0.4	0.5	0.5	0.6	0.7	0.7
PEEP	5	5	8	8	10	10	10	12

FiO_2	0.7	0.8	0.9
PEEP	14	14	14

My Patient is still Hypoxic.. What to Do?

Ventilatory Adjustments for Refractory hypoxemia:

- **I to E ratio management:**
  Increase Ti to obtain a lower I:E ratio and invert it if needed. Follow this sequence: 1:1 to 1.2:1 to 1:5:1 to 2:1.

  Monitor for hypercarbia and auto-PEEP.

When to Prone Intubated Patients?

- Persistent hypoxemia P:F <150 for 12 hours after optimal PEEP titration. Should be implemented early.
- ***Contraindications***: hemodynamic instability, shock, acute bleeding, tracheal surgery, pregnancy, increased ICP, increased intra-abdominal pressure, cardiac instability, unstable cervical spine, sternal instability.
- Patient must be in deep sedation and paralyzed.
- Duration of pronation 16-20hrs per session.
- Average pronation sessions per patient is 4.

When to Prone Intubated Patients?

- **PEEP management in pronation**:
  - ↓PEEP after pronation and ↑PEEP prior to return to the supine position in order to prevent de-recruitment.
  - ½ the difference: *for example, if PEEP is 8 in the prone position, but was 12 in the supine position, then consider increasing PEEP to 10 prior to return to supine condition.*
- When to end pronation sessions:
  Once P:F ratio is maintained above 150 while on supine position after 4 days.

General Considerations in COVID-ICU Rotation

Residents should be ready for daily morning rounds with the following information:

- Day count since COVID infection (symptoms) and not PCR test.
- COVID treatments. (received/ongoing/pending/not received).
- Antibiotics (duration/empiric or targeted, organisms detected)
- DVT prophylaxis (standard/high intensity/therapeutic, with justifications).
- Lines, tubes, … (inserted/required).

General Considerations in COVID-ICU Rotation

Residents should be ready for daily morning rounds with the following information:

- Settings of non-invasive ventilation if patient is not intubated (high flow nasal cannula/BIPAP).
- Ventilation settings (mode, Vt, RR, PEEP, fiO2, Ti or I:E ratio, driving pressure, PIP, Pplat, auto-PEEP if present, dysynchrony if present).
- Sedation agents (including paralysis with duration).
- Disposition from COVID-ICU to medical regular ICU/RCU/regular floor in severe COVID infection is after 20 days from symptoms (and not PCR).
- Consider consulting palliative team

AUBMC

COVID-ICU Management:
Diagnostics, Therapeutics, and Non-Invasive Ventilatory Support

Diagnostics:
- Daily workup: CBCD, chemistry, ABGs, CXR (especially if intubated).
- Labs to be monitored for worsening disease or drug toxicity: CRP, procalcitonin (to be done every other day).
- Pre-procedural labs: PT, PTT.
- Infectious workup: DTA or sputum for gram stain and culture, blood cultures, urine cultures, etc…
- If myocarditis/heart failure/MI are suspected: trop, proBNP, TTE.

Therapeutics:
1. **Dexamethasone**: 6mg IV/PO daily for 10 days (extend duration if still in resp. failure).
2. **Remdesivir:** 200mg IV on first day, then 100mg daily for 9 days. (Daily LFTs, discontinue if > 5x normal. Do not use if eGFR < 30).
3. **Convalescent Plasma:** Given once per week for 2 doses.

4. **Tocilizumab (Actemra):** *Call Pharmacy to adjust dose ext. 6571.*
   Dose: 4 to 8mg/kg IV for 2 doses at least 12 hours apart. *(for Il-6 >40 pg/ml). Avoid in severe infection, septic shock, hx of TB, hx of hepatitis, immunocompromised patients).*
   Screen for hepatitis B/C before using Actemra.
5. **Empiric Antibiotics:** Only if high clinical suspicion of ba
   infection, with
   Coordinate wit
6. **DVT prophylax**
   Standard: for a
   subQ daily, or
   CKD).
   High intensity:
   D-dimer and su
   coagulable sta
   BID, or heparir
   Note: Switch to
   confirmed PE/D
   suspicion. Mor

Non-Invasive Vent
Maneuvers: *(by ord*
1. **Non-rebreathe**
   oxygen flow of
   to flush if need
2. **High flow nasal**
   settings 60L/m
   Increase in fiO2

3. **Self-Pronation**:
   - *Requires cooperation and ability of the patient to rotate independently.*
   - *Contraindicated if: severe resp. distress, immediate need for intubation, hemodynamic instability, altered mental status, recent spine or abd. surgery, facial injury, pregnancy, morbid obesity, seizures.*

   Protocol of Self-Pronation:
   - 30min to 2 hrs on belly,
   - then 30min to 2 hrs on right side

When to intubate your patient?
- If refractory or no improving hypoxemia. *(PaO2 <60 and SpO2 < 90%).*
- If severe respiratory distress (RR>35), with accessory muscle use.
- If contraindicated or not improving on non-invasive methods and self-pronation.
- If hemodynamic instability or decrease

AUBMC

COVID-ICU Management:
Invasive Mechanical Ventilation

Post-Intubation Management:
- Insert NG tube.
- Insert Central line and arterial line.
- Obtain a CXR.
- Obtain ABGs one hour after initial settings.
- Insert foley catheter for accurate I/O.
- In case of hypotension post-induction, give 500-1000mL of NSS bolus. If patient remains hypotensive start norepinephrine.
- Start sedation: *(target RASS -3 or -4)*
  - Analgesia: Fentanyl or remifentanil as per protocol.
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Initial settings on Mechanical Ventilator:
- AC – VC or VC+ mode.
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- PEEP: 10 cmH2O.
- FiO2: 100%.
- Respiratory rate: 18-24.
- I to E ratio: set Ti to have initial ratio at 1:1.
- Peak pressure <35 and Pplat <30.

Non-Ventilatory Adjustments:
- Conservative fluid management: Diuresis plan monitored by I/O, hemodynamics, and creatinine.
- Increase sedation to target RASS -5 (unarousable) in case of ventilator-patient dyssynchrony.
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