

# Poškození mozku a protektivní ventilace

TOMÁŠ TYLL



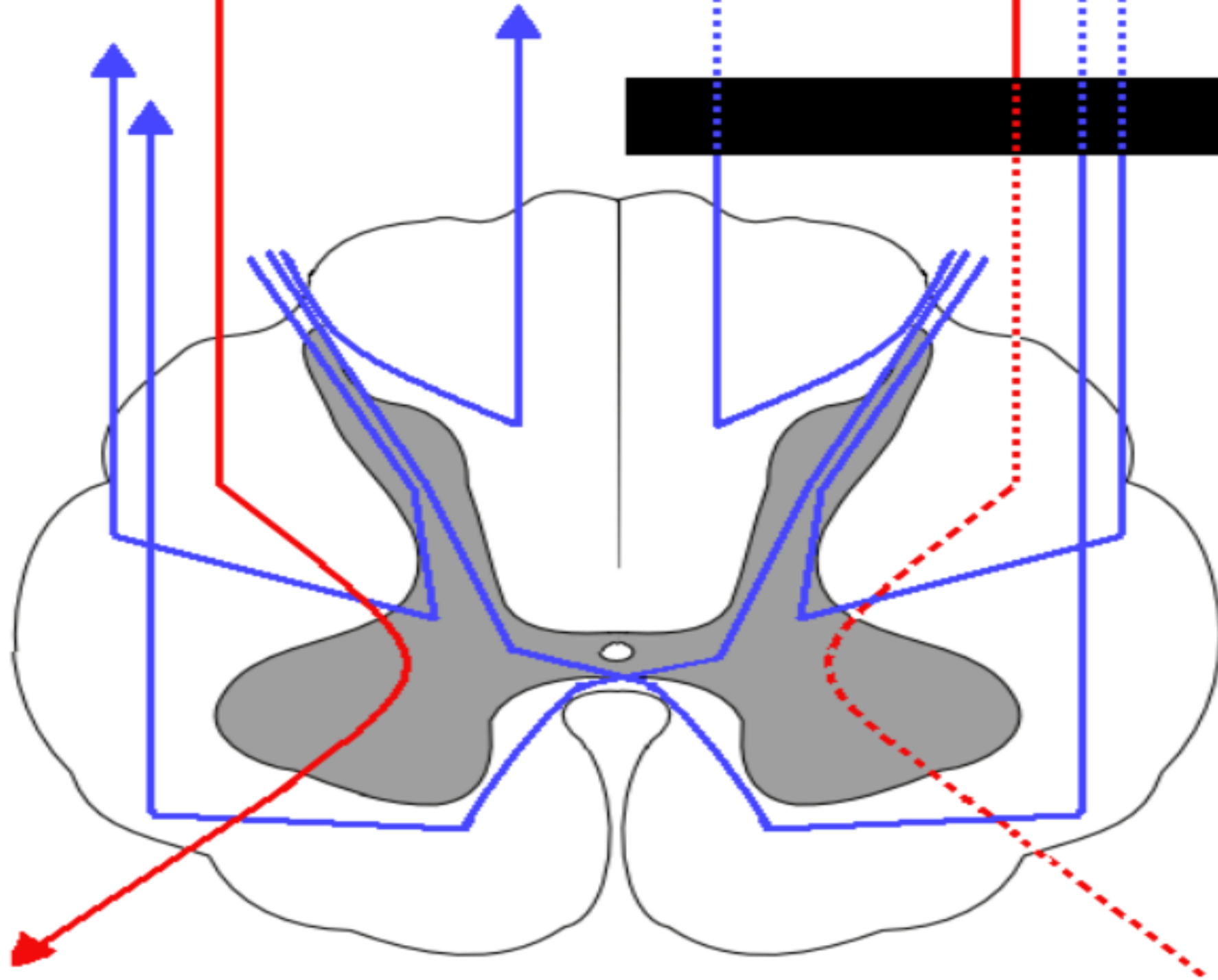
**ÚVN**

ÚSTŘEDNÍ VOJENSKÁ NEMOCNICE  
Vojenská fakultní nemocnice Praha



ŠKOLENÍ PRIMÁŘŮ NEUROLOGIE I 2025





in traumatic brain

Acute and Critical Care 2022 February 37(1):35-44  
<https://doi.org/10.4266/acc.2021.01193>

MA, AND  
F THE BRAIN.



# Respiratory Insufficiency in Combat Casualties:

## II. Pulmonary Edema Following Head Injury

Annals of Surgery  
July 1969

| Survival Time | Number of Patients | No Pathology Noted | Edema Alveolar Hemorrhage Congestion | Pleural Effusion | Atelectasis | Pneumonia | Hyaline Membrane |
|---------------|--------------------|--------------------|--------------------------------------|------------------|-------------|-----------|------------------|
| 0             | 20                 | 3                  | 17                                   | 0                | 1           | 0         | 0                |
| <24 hours     | 14                 | 0                  | 11                                   | 4                | 2           | 3         | 0                |
| 1-7 days      | 15                 | 0                  | 15                                   | 3                | 3           | 3         | 1                |
| >7 days       | 7                  | 0                  | 5                                    | 2                | 1           | 2         | 0                |

# Epidemiologie

*J Trauma.* 2003;55:106–111.

## The Development of Acute Lung Injury Is Associated with Worse Neurologic Outcome in Patients with Severe Traumatic Brain Injury

Martin C. Holland, MD, Robert C. Mackersie, MD, Diane Morabito, RN, MPH, Andre R. Campbell, MD, Valerie A. Kivett, BS, Rajiv Patel, BS, Vanessa R. Erickson, BS, and Jean-Francois Pittet, MD

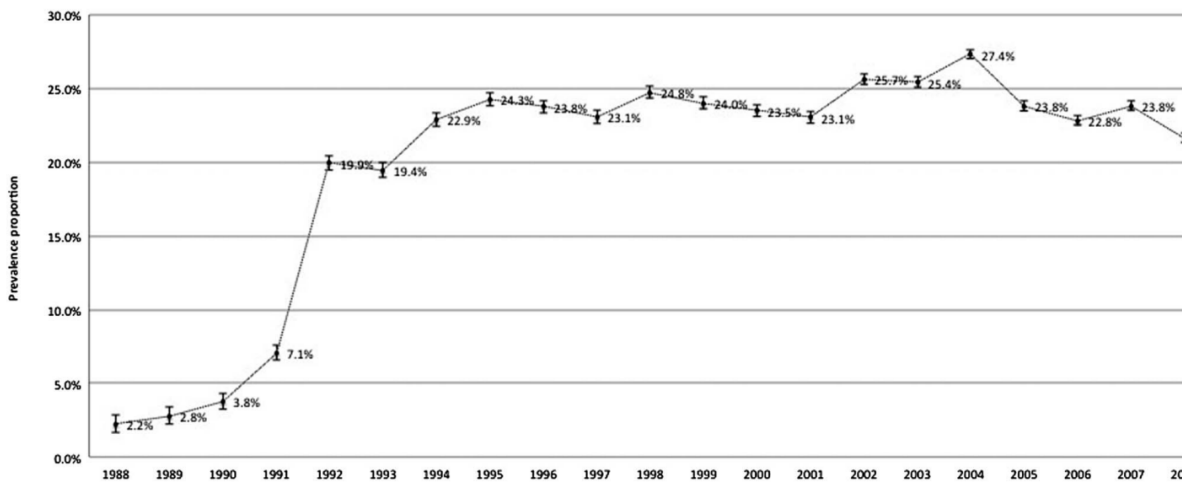
| Outcome   | Odds ratio (OR) | 95% CI    | P-value |
|-----------|-----------------|-----------|---------|
| Mortality | 1.13            | 1.01 1.26 | 0.029   |

## Incidence and Outcomes of Acute Respiratory Distress Syndrome in Brain-Injured Patients Receiving Invasive Ventilation: A Secondary Analysis of the ENIO Study

|                     |      |           |        |
|---------------------|------|-----------|--------|
| Hospital LOS (days) | 6.97 | 5.38 8.56 | <0.001 |
| Ventilator Days     | 4.85 | 3.86 5.83 | <0.001 |

## Epidemiology and Outcomes of Acute Respiratory Distress Syndrome Following Isolated Severe Traumatic Brain Injury

*Journal of Intensive Care Medicine*  
2022, Vol. 37(1) 68–74



**CONCLUSION:** Our analysis demonstrates that ARDS/ALI is common after TBI. Despite an overall reduction of in-hospital mortality, ARDS/ALI carries a higher risk of in-hospital death after TBI.

*Neurosurgery* 71:795–803, 2012

# Weaning Outcomes in Patients with Brain Injury

*Neurocrit Care* (2022) 37:649–659

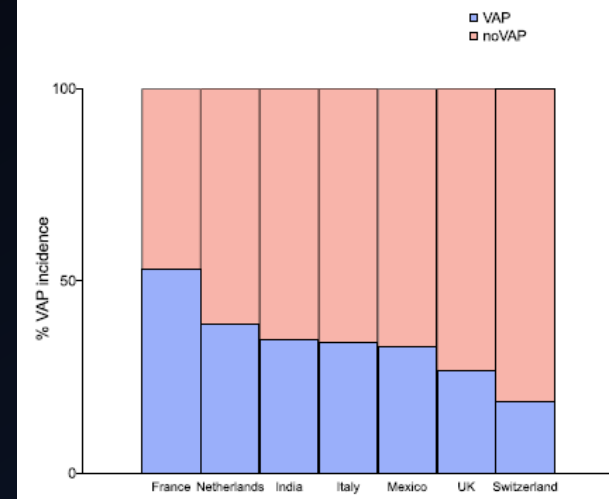
<https://doi.org/10.1007/s12028-022-01584-2>

## Conclusions

According to pooled data from our cohort, patients with acute brain injury, compared with patients without brain injury, present a higher odds of unplanned extubation after weaning was started, a lower odds of extubation after the first attempt, and a higher risk of reintubation. The gradual reduction of PS was the main method of weaning in patients with acute brain injury and patients without brain injury.

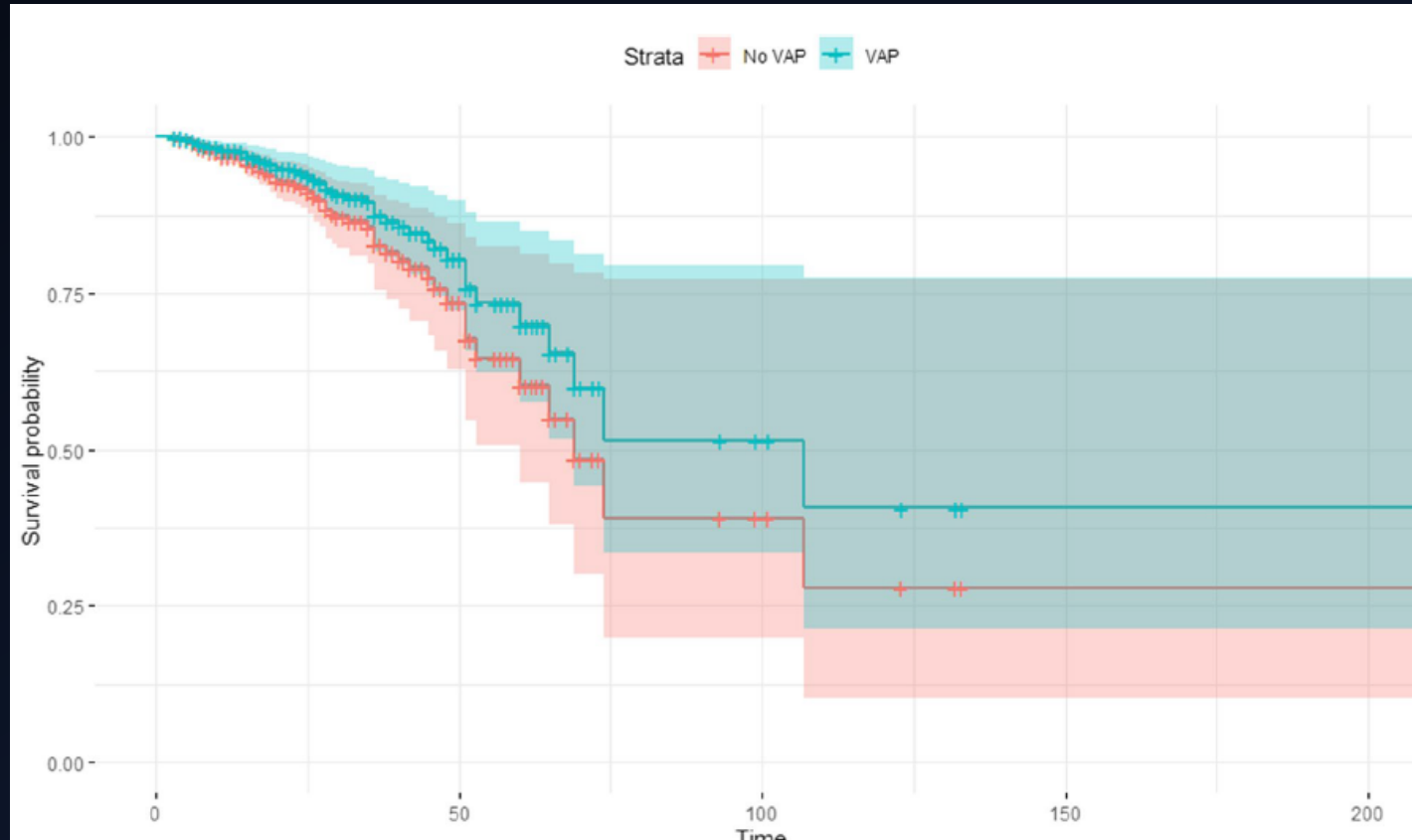
# Ventilator-associated pneumonia in neurocritically ill patients: insights from the ENIO international prospective observational study

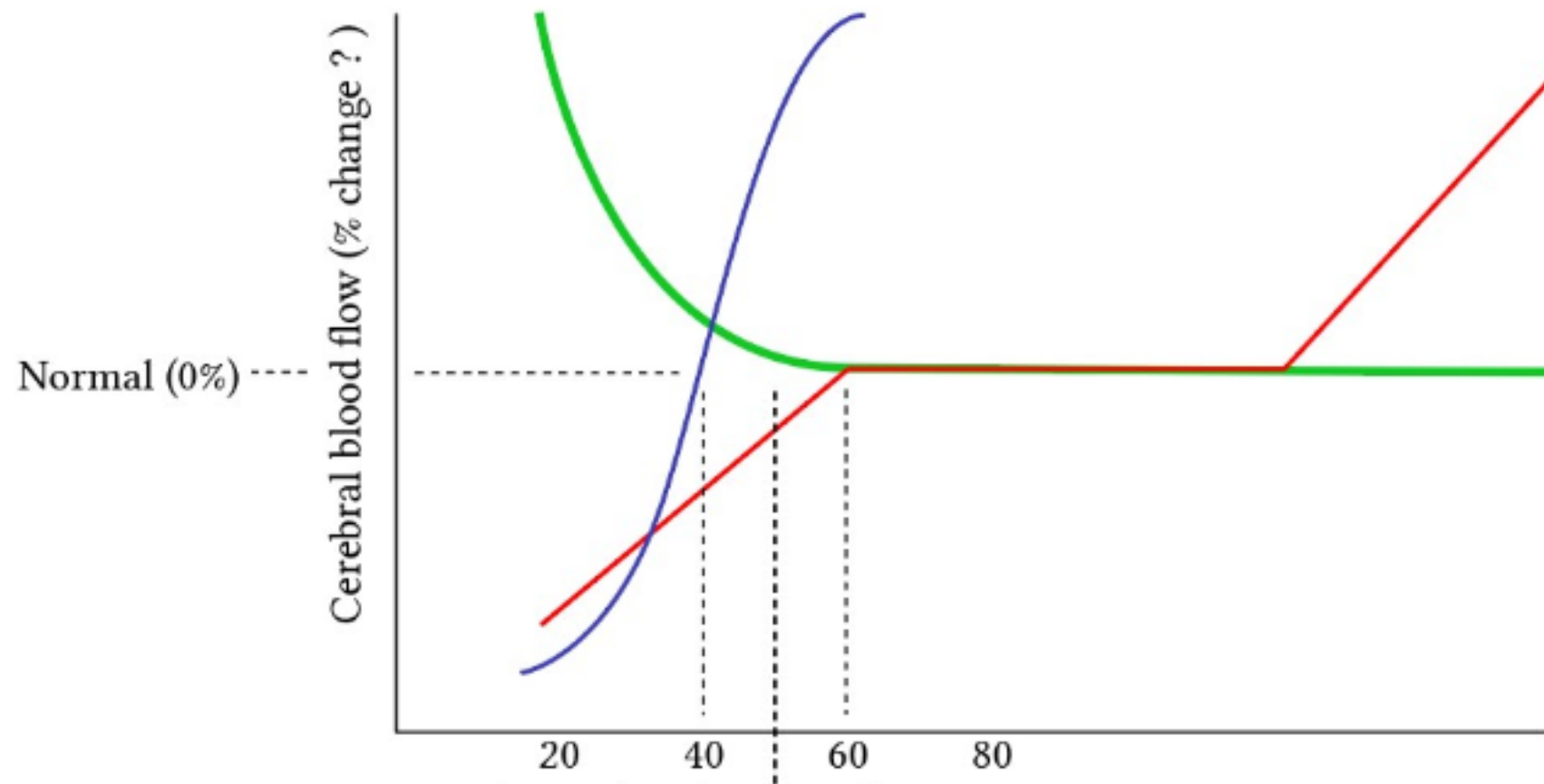
Battaglini et al. *Respiratory Research* (2023) 24:146  
<https://doi.org/10.1186/s12931-023-02456-9>



## Conclusions

VAP is common in neurocritically ill patients but highly variable across countries and type of brain injury. Male gender, intracranial probe, EVD, tracheobronchitis, and therapeutic hypothermia impact on VAP. VAP not clearly influence mortality but ICU-LOS and duration of mechanical ventilation. Further studies accounting for antibiotic use and isolated pathogens in large cohorts of neurocritically ill patients should be guaranteed.





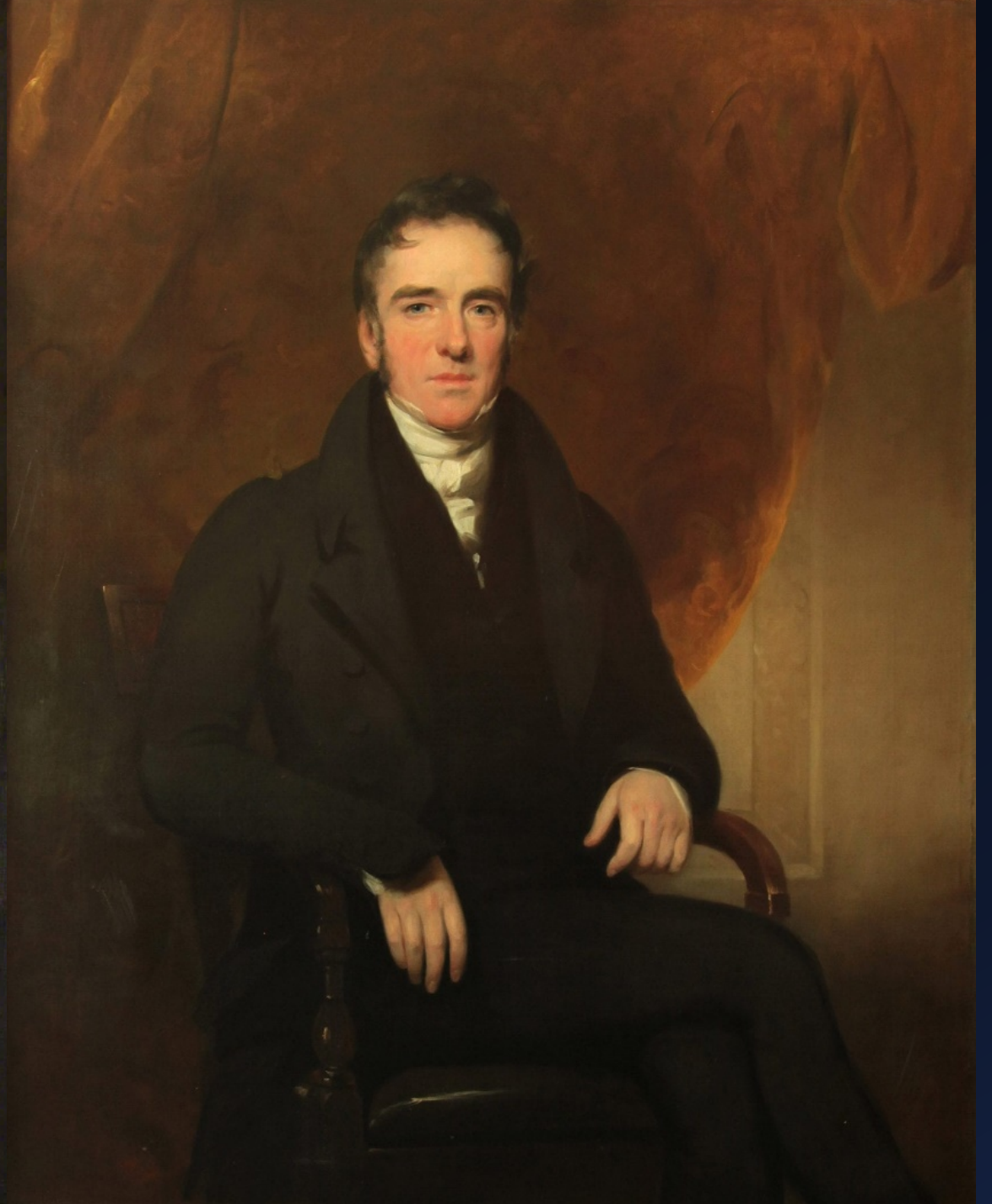
Normal (0%) -----

Pressure (mmHg)

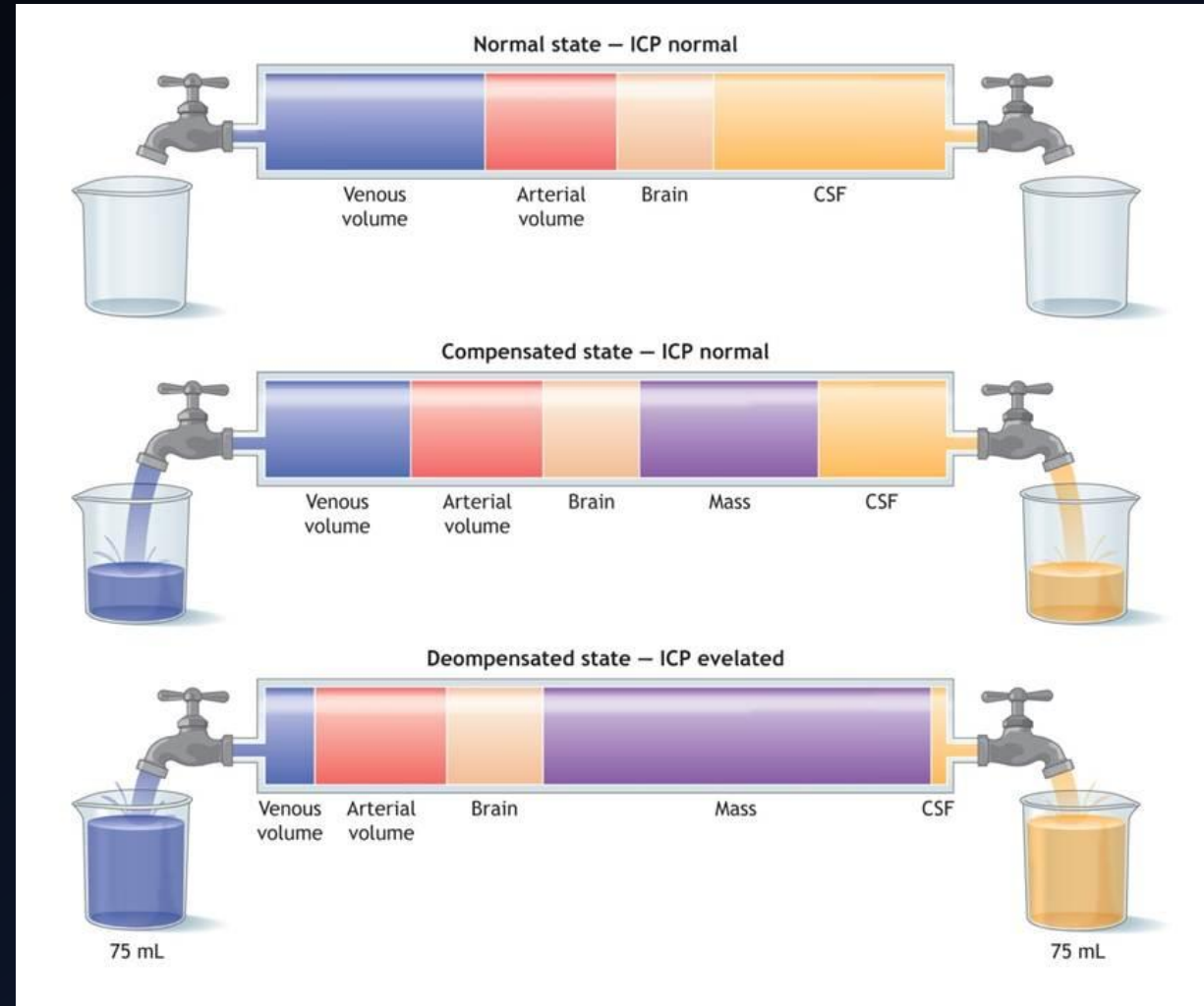
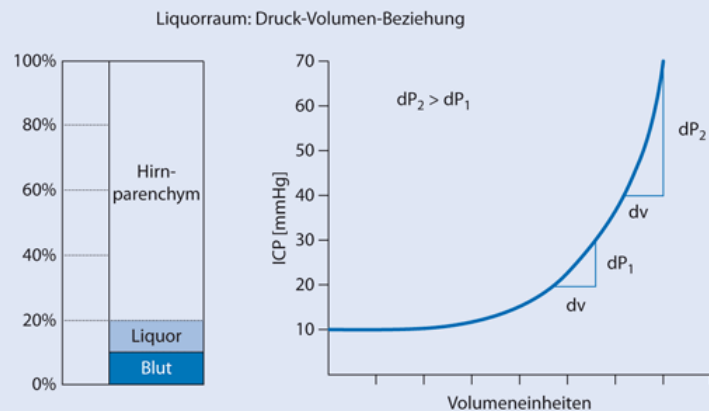
40 mmHg (PaCO<sub>2</sub>): the normal value for PaCO<sub>2</sub>

60 mmHg (MAP): the mean arterial pressure below which cerebral autoregulation mechanisms cannot maintain stable blood flow

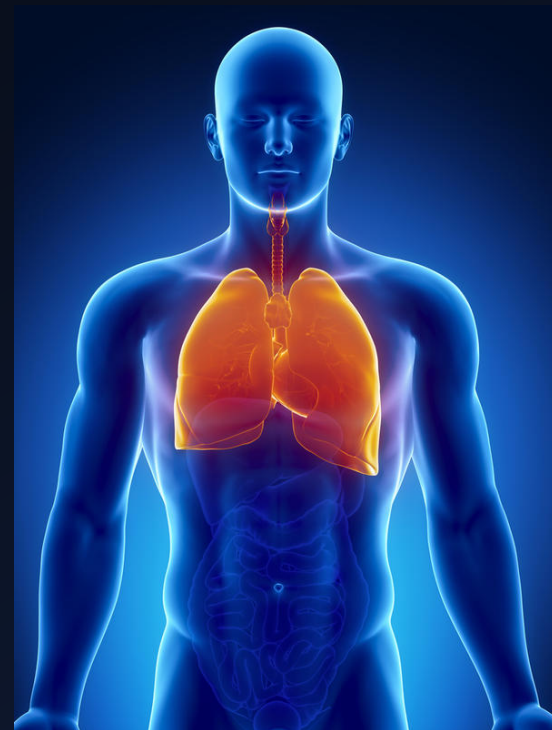
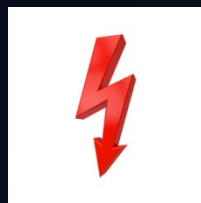
50 mmHg (PaO<sub>2</sub>): the threshold where hypoxia begins to influence cerebral blood flow



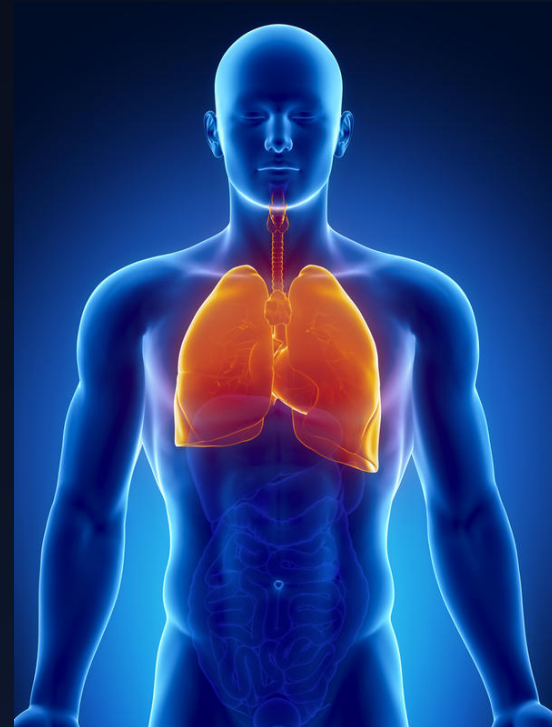
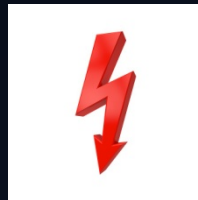
- $CPP = MAP - ICP$
- CBF   CBV   ICP



= Interakce mozek-plíce

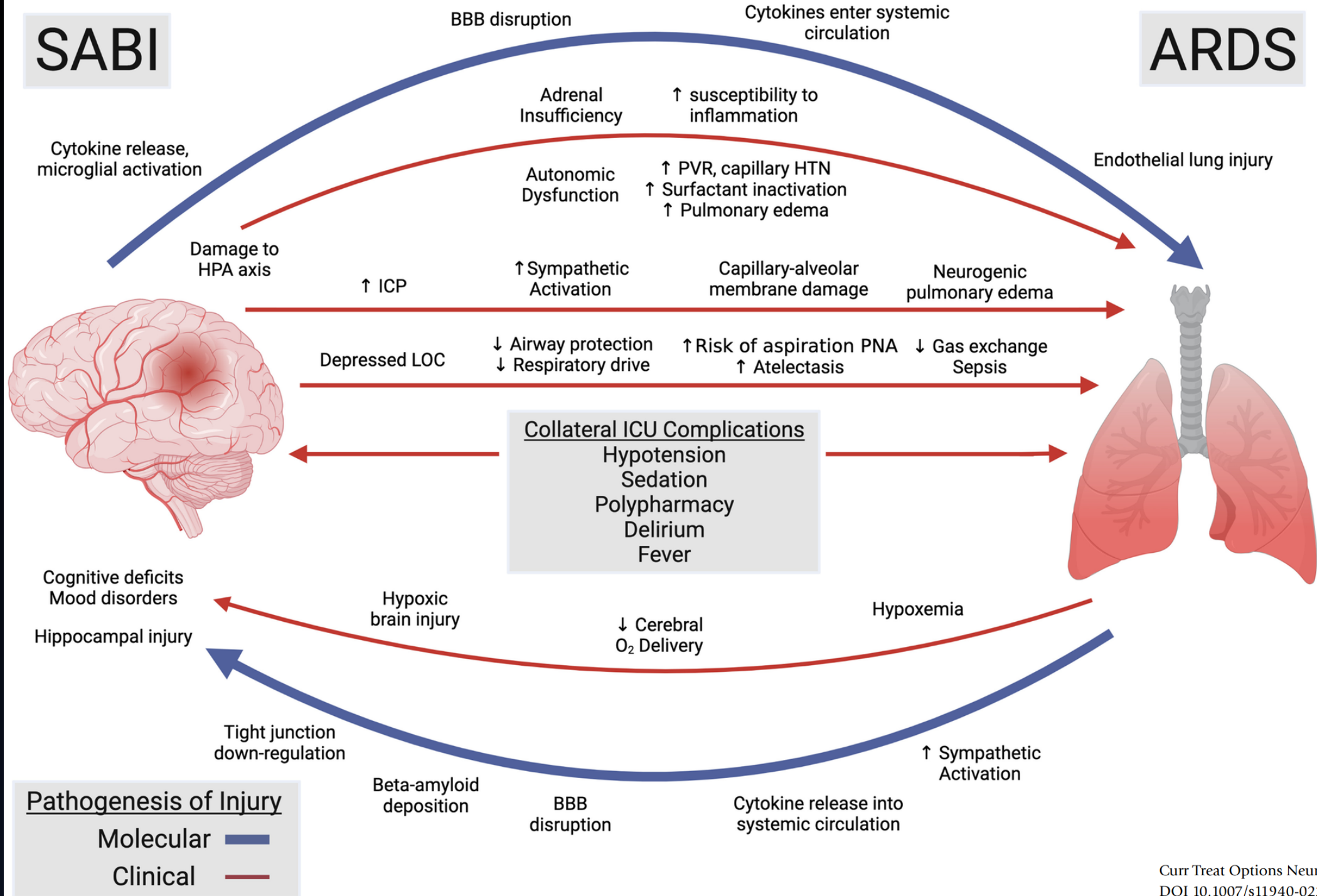


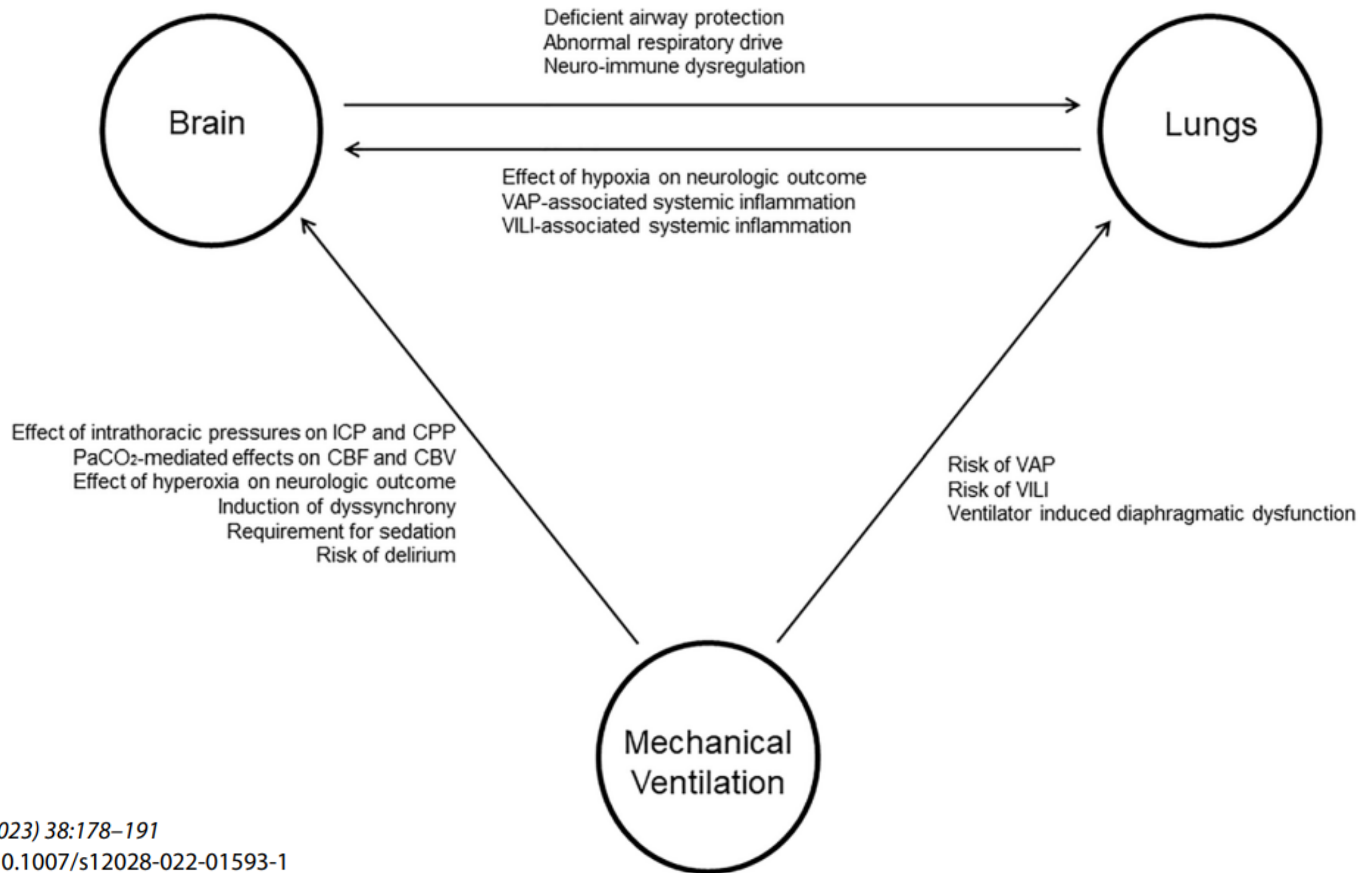
= Interakce plíce - mozek



# SABI

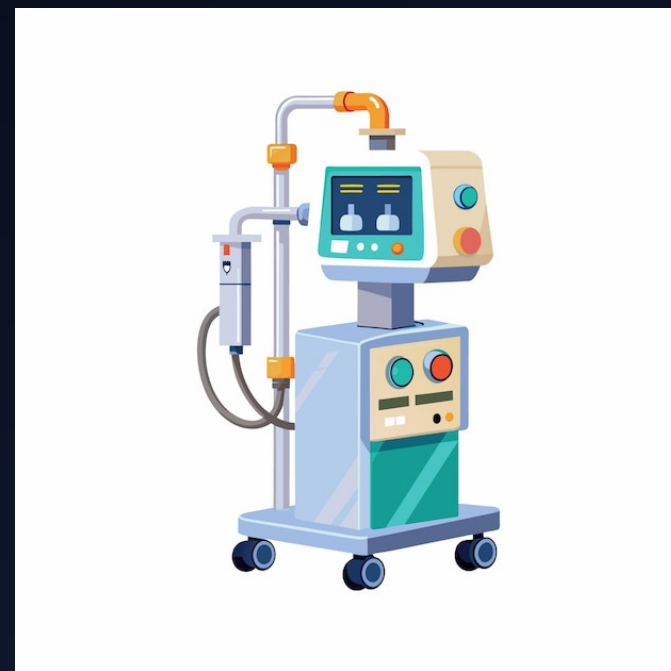
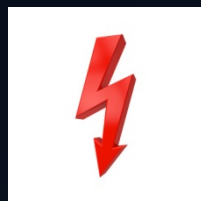
# ARDS





# VABI

## = Interakce UPV - mozek



# Ventilator-associated Brain Injury

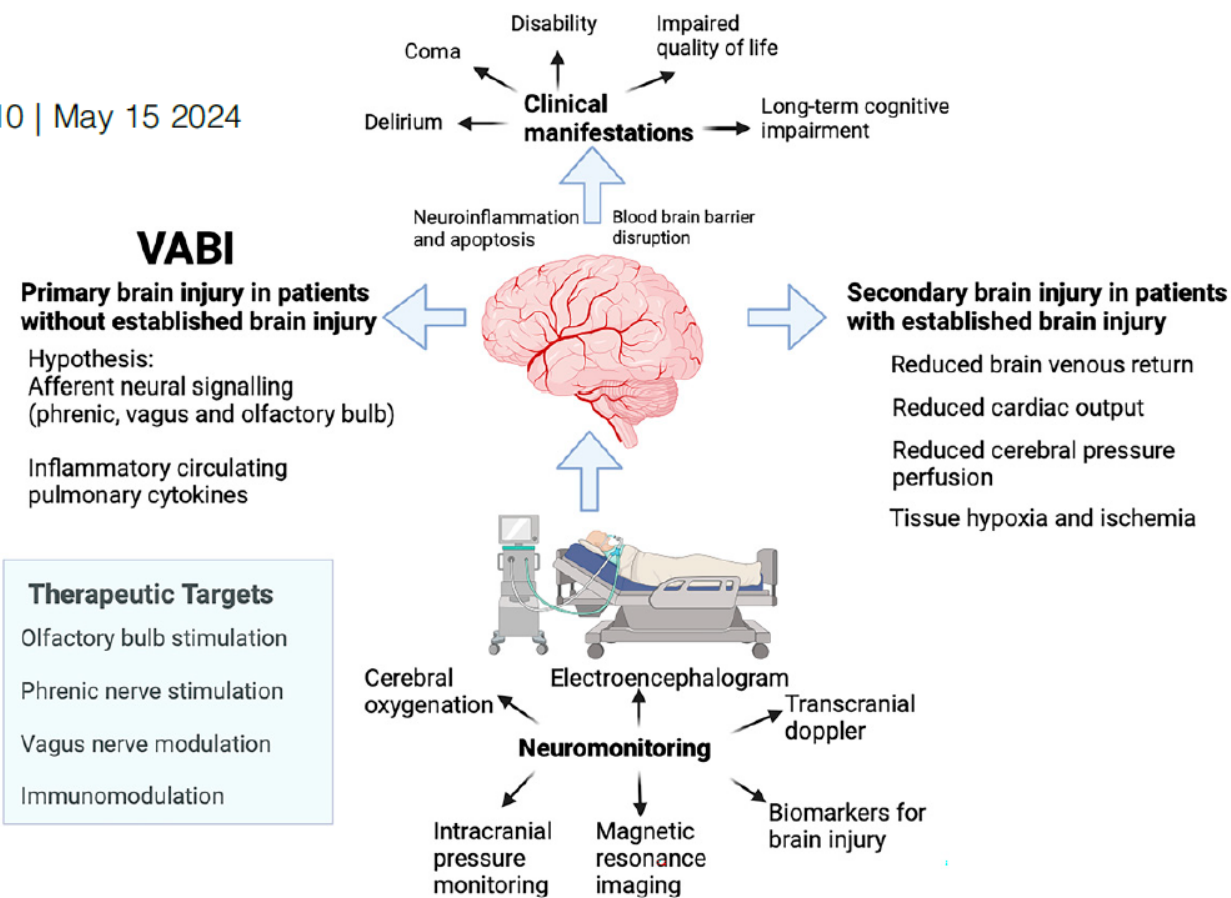
## A New Priority for Research in Mechanical Ventilation

Thiago Bassi<sup>1,2,4</sup>, Shaurya Taran<sup>1,2</sup>, Timothy D. Girard<sup>5</sup>, Chiara Robba<sup>6,7</sup>, and Ewan C. Goligher<sup>1,2,3,8</sup>

<sup>1</sup>Department of Medicine, Division of Respiriology, University Health Network, Toronto, Ontario, Canada; <sup>2</sup>Interdepartmental Division of Critical Care Medicine and <sup>3</sup>Department of Physiology, University of Toronto, Toronto, Ontario, Canada; <sup>4</sup>Lungpacer Medical Inc., Vancouver, British Columbia, Canada; <sup>5</sup>Center for Research, Investigation, and Systems Modeling of Acute Illness, Department of Critical Care Medicine, University of Pittsburgh School of Medicine, Pittsburgh, Pennsylvania; <sup>6</sup>Department of Surgical Sciences and Integrated Diagnostics, University of Genoa, Genoa, Italy; <sup>7</sup>Anesthesia and Critical Care, Scientific Institute for Research, Hospitalization and Healthcare Policlinico San Martino, Genoa, Italy; and <sup>8</sup>Toronto General Hospital Research Institute, Toronto, Ontario, Canada

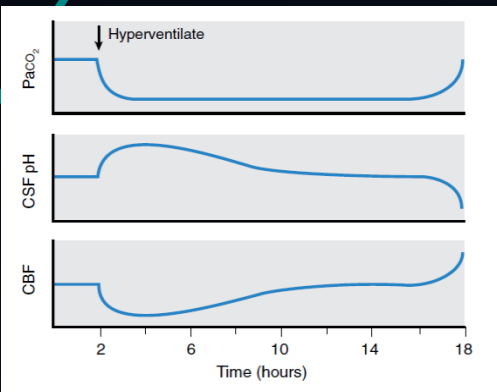
American Journal of Respiratory and Critical Care Medicine Volume 209 Number 10 | May 15 2024

Aloysius Alzheimer



# paCO<sub>2</sub>

- Hypokapnie opuštěna
- Hyperkapnie nebezpečná



Resuscitation 91 (2015) 32–41

## Use of Hyperventilation in Patients with Severe Head Injury

J. D. Ward, H. F. Young, J. P. Muizelaar, and S. Choi

*Richmond, Virginia*

*Neurosurgery, Vol. 24, No. 6 June 1989*

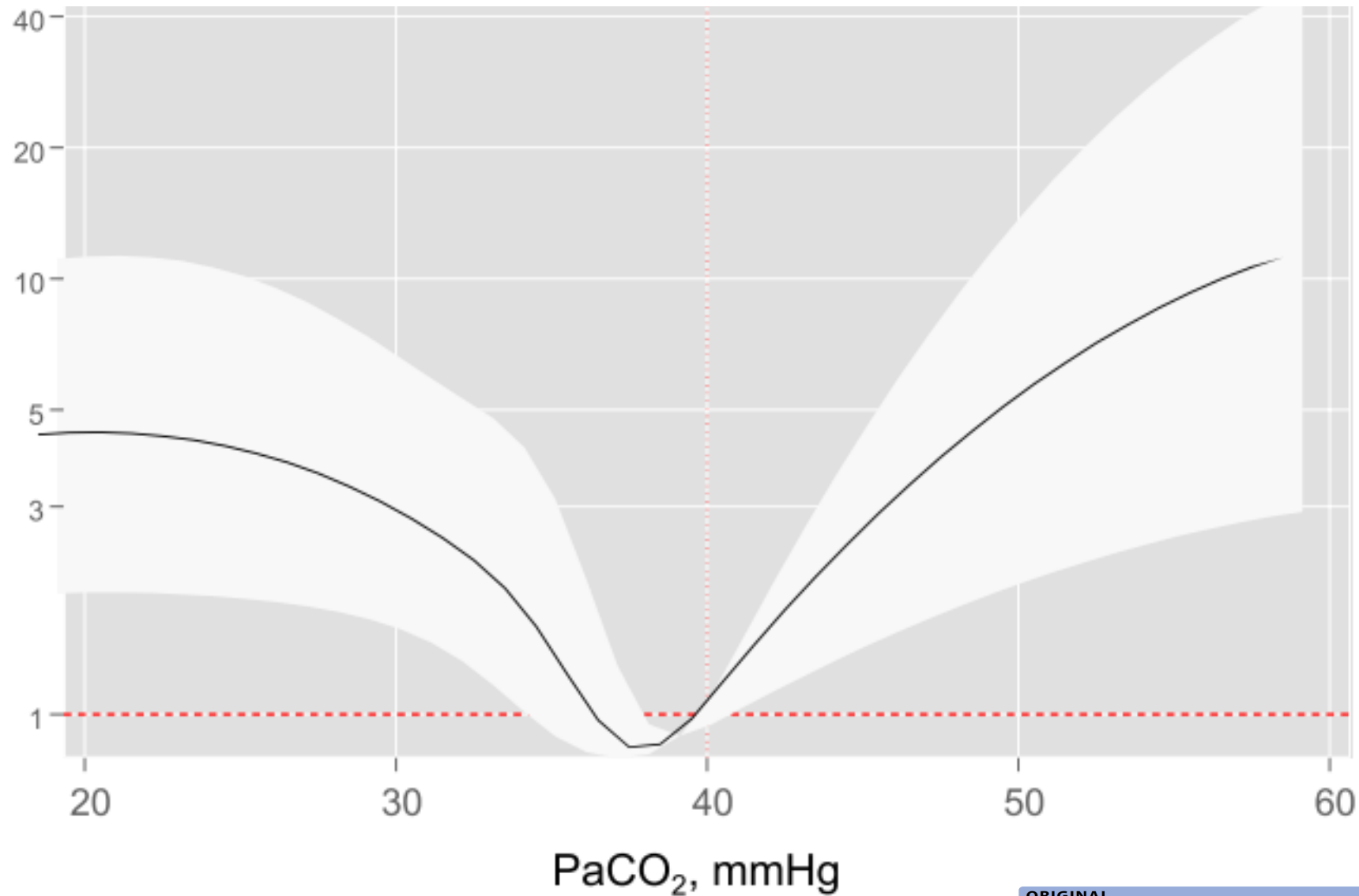
In summary, prophylactic hyperventilation in patients with severe head injury is not recommended.

## Effects of PaCO<sub>2</sub> derangements on clinical outcomes after cerebral injury: A systematic review<sup>☆</sup>

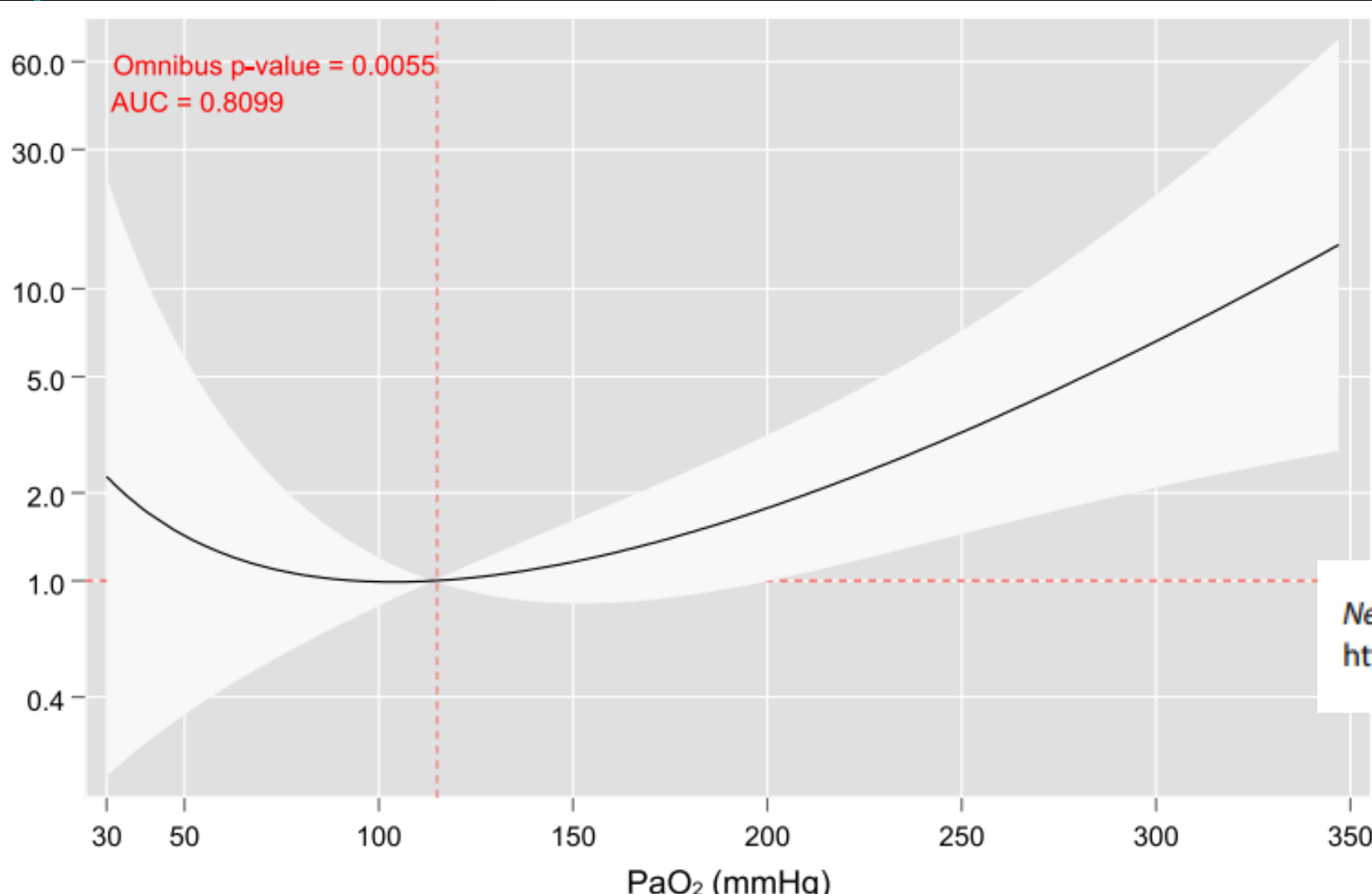
Brian W. Roberts<sup>a,\*</sup>, Paul Karagiannis<sup>a</sup>, Michael Coletta<sup>a</sup>, J. Hope Kilgannon<sup>a</sup>,  
Michael E. Chansky<sup>a</sup>, Stephen Trzeciak<sup>a,b</sup>

**Conclusion:** The majority of studies in this report found exposure to hypocapnia and hypercapnia after cerebral injury to be associated with poor clinical outcome. However, the optimal PaCO<sub>2</sub> range associated with good clinical outcome remains unclear.

$\text{PaCO}_2 > 35$  and to 45 mmHg; mild hypocapnia as 32–35 mmHg; severe hypocapnia as 26–31 mmHg, forced hypocapnia as  $< 26$  mmHg, and hypercapnia as  $> 45$  mmHg.



# Individualized Thresholds of Hypoxemia and Hyperoxemia and their Effect on Outcome in Acute Brain Injured Patients: A Secondary Analysis of the ENIO Study



*Neurocrit Care* (2024) 40:515–528  
<https://doi.org/10.1007/s12028-023-01761-x>

# Effects of PEEP on the Intracranial System of Patients With Head Injury and Subarachnoid Hemorrhage: The Role of Respiratory System Compliance

Anselmo Caricato, MD, Giorgio Conti, MD, Francesco Della Corte, MD, Aldo Mancino, MD, Federico Santilli, MD, Claudio Sandroni, MD, Rodolfo Proietti, MD, and Massimo Antonelli, MD

*J Trauma.* 2005;58:571–576

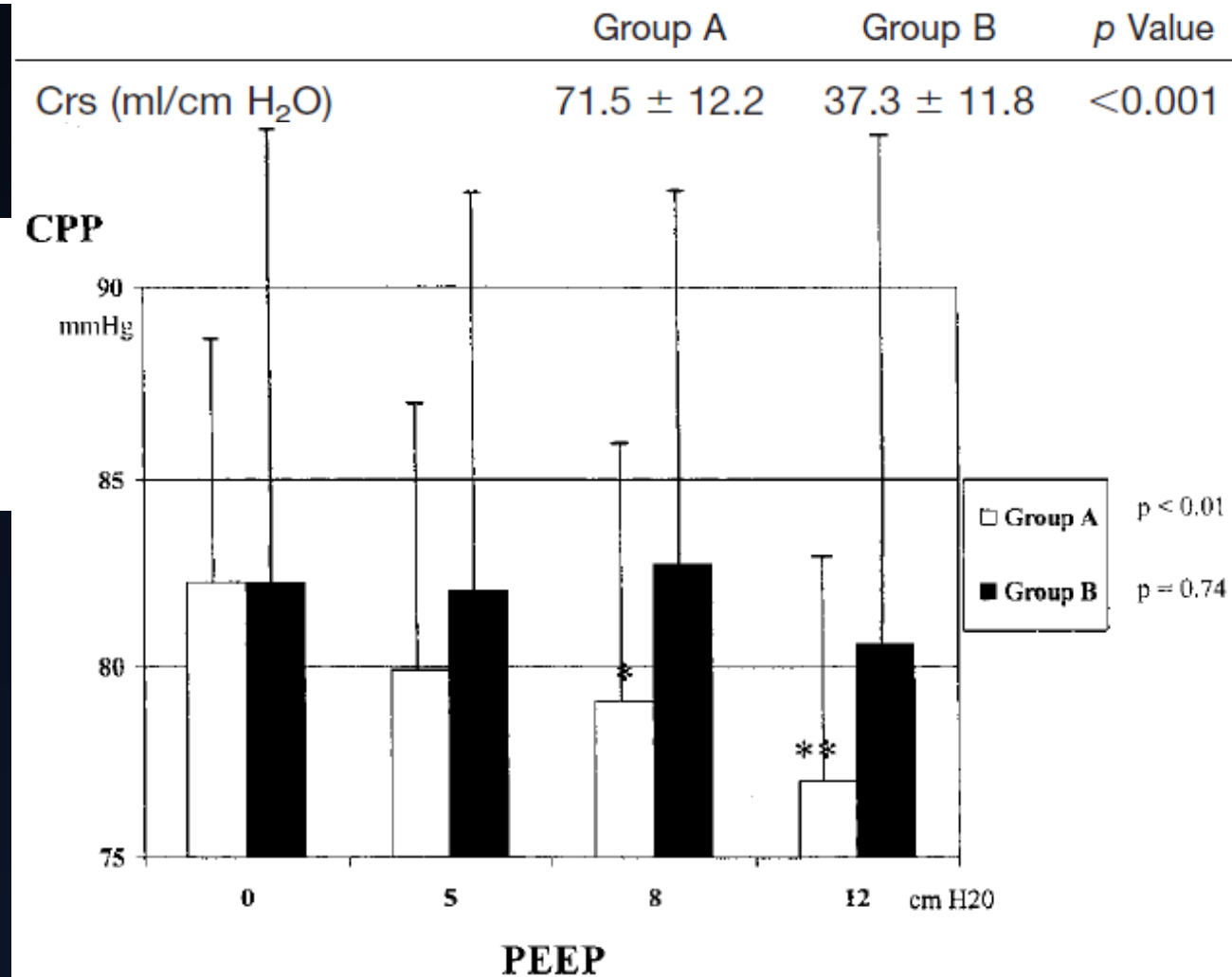
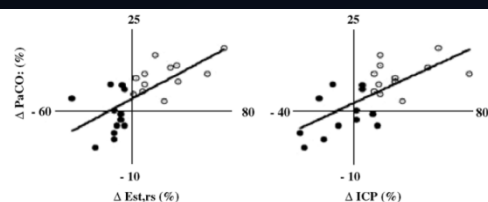
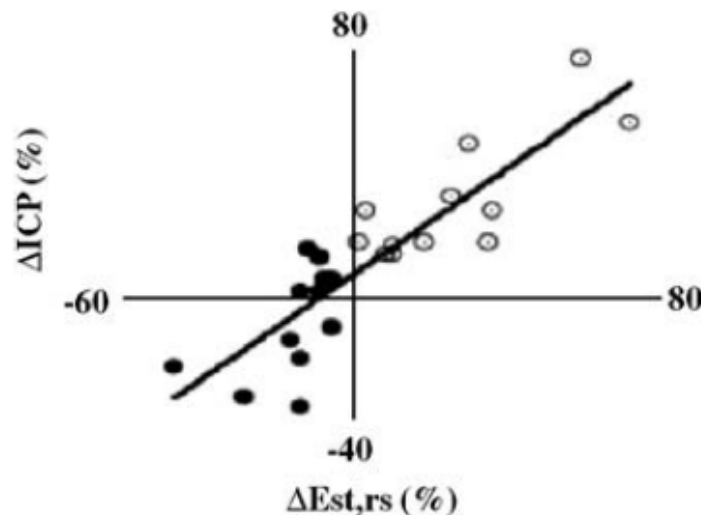
- Plíce se špatnou  $C_{rs}$  = „izolátor“

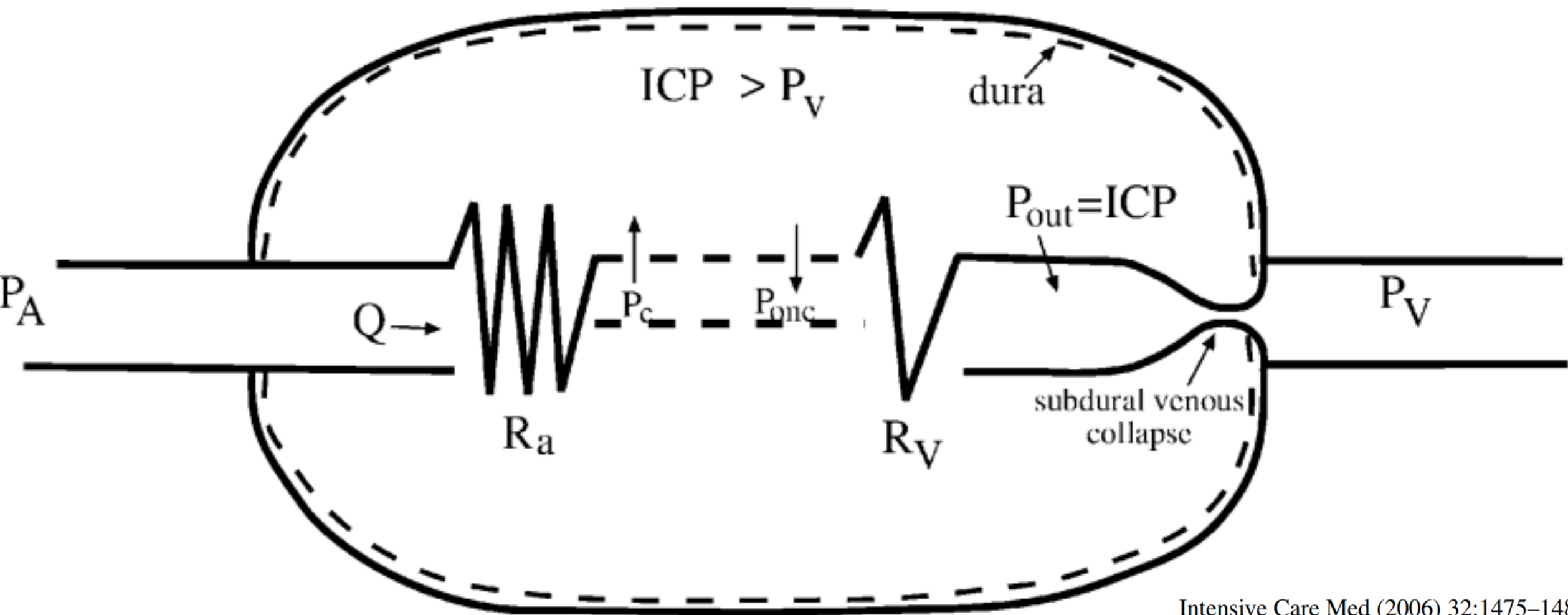
Intensive Care Med (2005) 31:373–379  
DOI 10.1007/s00134-004-2491-2

ORIGINAL

Luciana Mascia  
Salvatore Grasso  
Tommaso Fiore  
Francesco Bruno  
Maurizio Berardino  
Alessandro Ducati

**Cerebro-pulmonary interactions during the application of low levels of positive end-expiratory pressure**



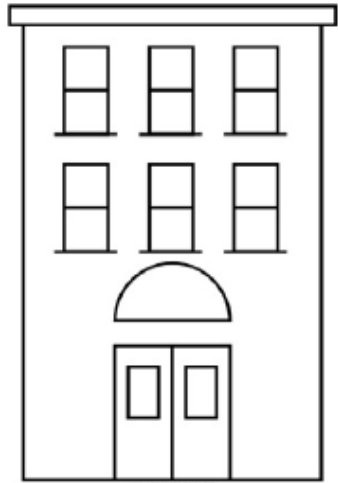


Intensive Care Med (2006) 32:1475–1484  
DOI 10.1007/s00134-006-0294-3

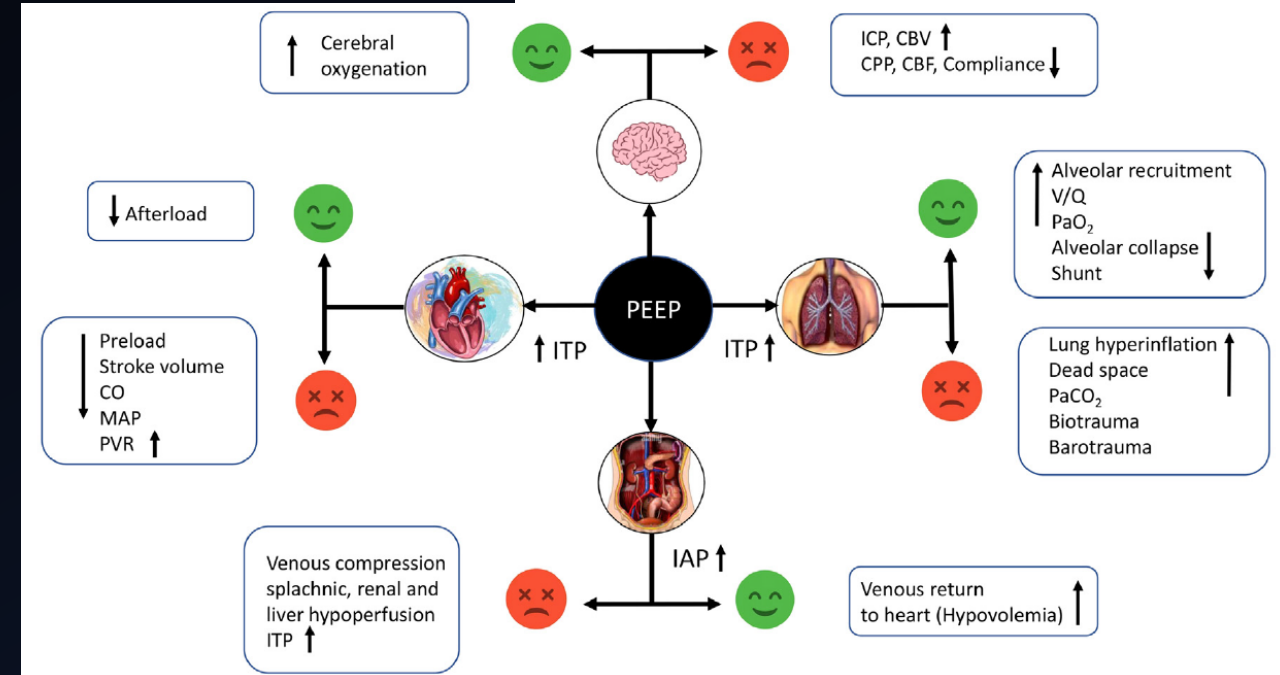
**The “Lund Concept” for the treatment of severe head trauma – physiological principles and clinical application**

# Effects of positive end-expiratory pressure on intracranial pressure, cerebral perfusion pressure, and brain oxygenation in acute brain injury: Friend or foe? A scoping review

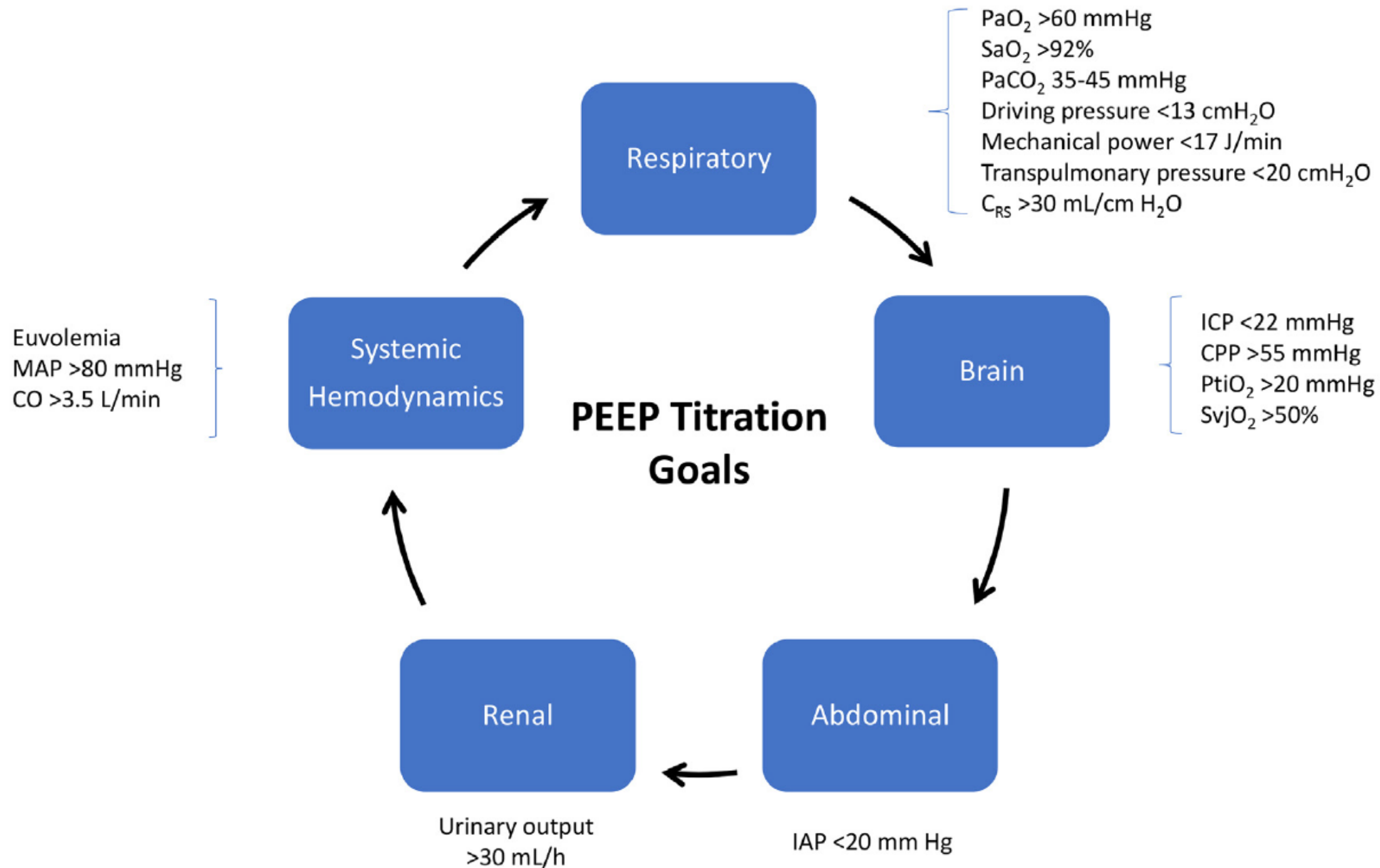
*Journal of Intensive Medicine 4 (2024) 247–260*



**D**amage  
**E**uvolemia  
**P**EEP  $\leq$  ICP  
**A**rterial blood gases  
**R**elationship between ITP, IAP, and ICP  
**T**itration  
**M**onitoring  
**E**valuate the use of PEEP  
**N**ormal systemic hemodynamics  
**T**apered gradually



**Conclusion:** PEEP can be safely used in patients with ABI to improve gas exchange keeping in mind its potentially harmful effects, which can be predicted with adequate monitoring supported by bedside non-invasive neuromonitoring tools.

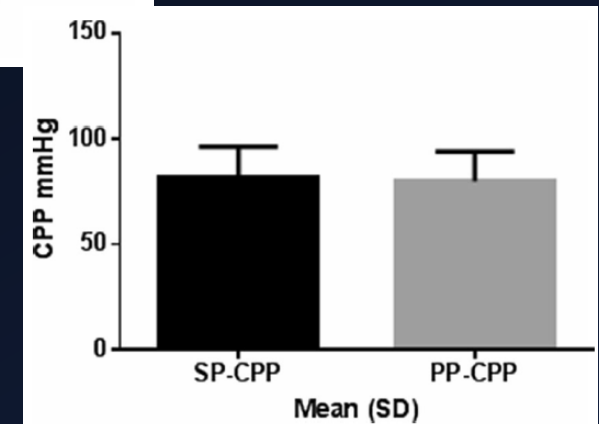
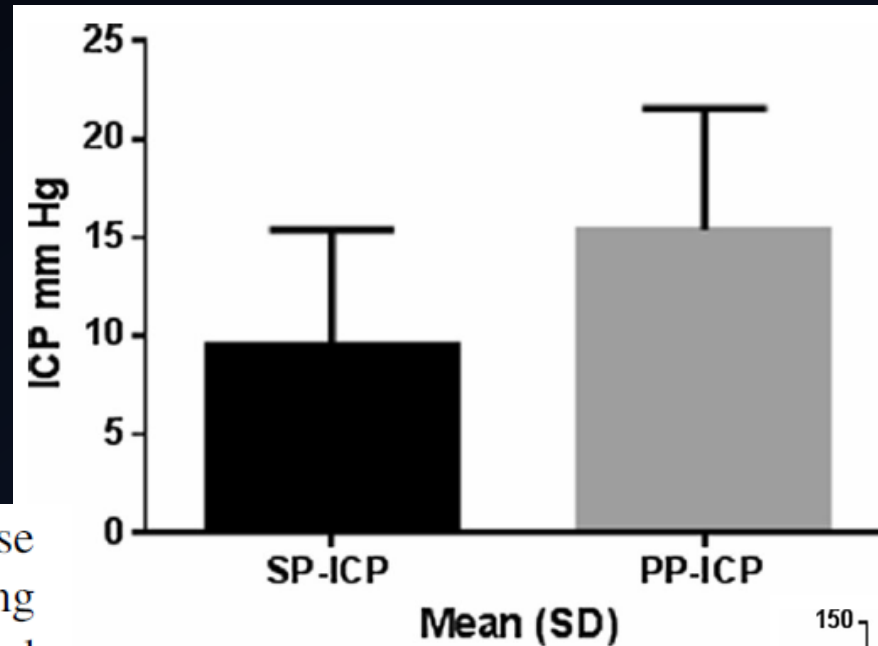


# Pronační poloha

## Does Prone Positioning Increase Intracranial Pressure? A Retrospective Analysis of Patients with Acute Brain Injury and Acute Respiratory Failure

Christian Roth · Andreas Ferbert · Wolfgang Deinsberger ·  
Jens Kleffmann · Stefanie Kästner · Jana Godau ·  
Marc Schöler · Michael Tryba · Markus Gehling

Neurocrit Care (2014) 21:186–191



*Conclusions* The analyzed data allow a more precise understanding of changes in ICP and oxygenation during prone positioning in patients with acute brain injury and almost normal baseline ICP. Our study shows a moderate, yet significant elevation of ICP during prone positioning. However, the achieved increase of oxygenation by far exceeded the changes in ICP. It is evident that continuous monitoring of cerebral pressure is required in this patient group.

## Prone Position Ventilation in Neurologically Ill Patients: A Systematic Review and Proposed Protocol

Although elevations in intracranial pressure and reductions in cerebral perfusion pressure do occur during proning, they may not occur to a degree that would warrant exclusion of prone ventilation as a treatment modality for patients with acute respiratory distress syndrome and concomitant neurologic diagnoses. In cases where intracranial pressure, cerebral perfusion pressure, and brain tissue oxygenation can be monitored, prone position ventilation should be considered a safe and viable therapy.

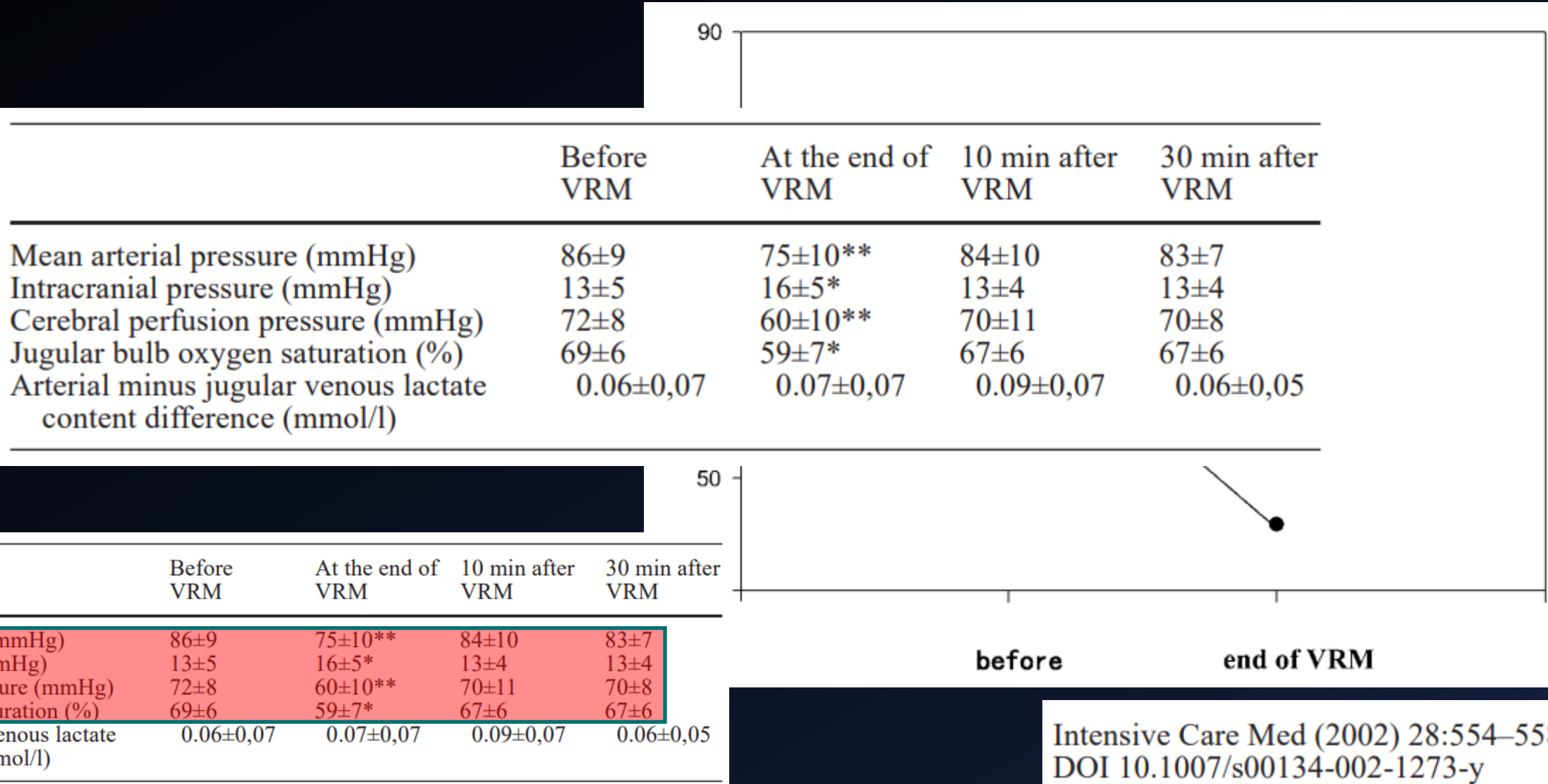
**Critical Care Medicine**

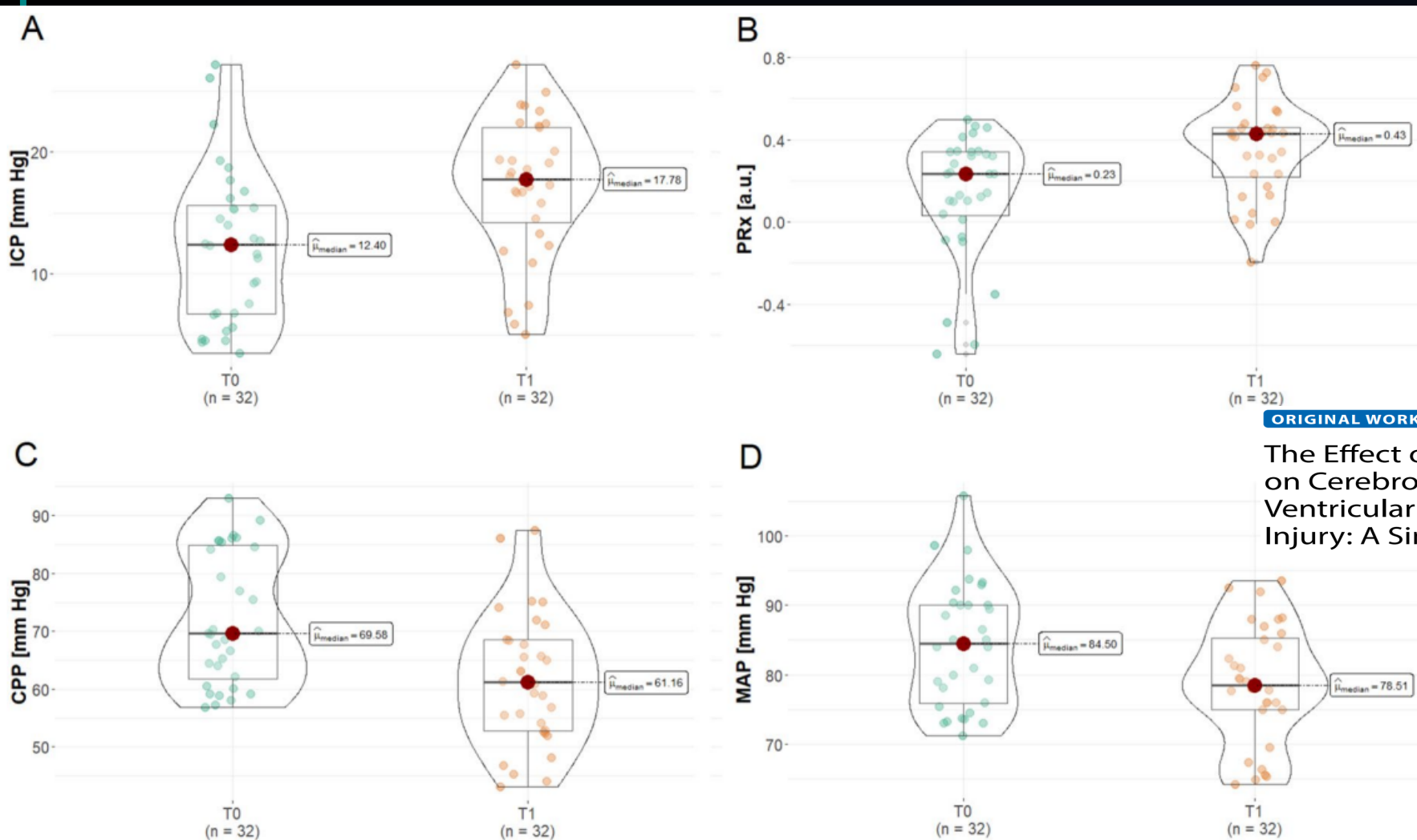
**March 2021 , Volume 49 ( 3 ), p e269 –  
e278**

## Feasibility of Prone Positioning for Brain-injured Patients with Severe Acute Respiratory Distress Syndrome: A Systematic Review and Pilot Study (ProBrain)

Brain-injured patients are largely excluded from studies evaluating prone position in acute respiratory distress syndrome. However, cerebral blood flow seems not to be altered considering increasing of mean arterial pressure during the session. Systematic exclusion of brain-injured patients appears to be unfounded, and prone position, while at risk in brain-injured patients, should be evaluated on these patients to review recommendations, considering close monitoring of neurologic and hemodynamic parameters.

# Lung recruitment maneuver in patients with cerebral injury: effects on intracranial pressure and cerebral metabolism





ORIGINAL WORK

The Effect of Recruitment Maneuvers  
on Cerebrovascular Dynamics and Right  
Ventricular Function in Patients with Acute Brain  
Injury: A Single-Center Prospective Study

Neurocrit Care  
<https://doi.org/10.1007/s12028-024-01939-x>

© 2024

| Parameter   | T0               | T1                  | p value          | $r_{rb}$ | $\Delta$ change          |
|-------------|------------------|---------------------|------------------|----------|--------------------------|
| ICP (mm Hg) | 12.4 (6.7–15.8)  | 17.8 (13.9 to 22.1) | <b>&lt;0.001</b> | 0.70     | 4.8 (2.5 to 8.2)         |
| CPP (mm Hg) | 69.6 (61.3–85.0) | 61.2 (52.7 to 68.5) | <b>&lt;0.001</b> | 0.73     | – 12.8 (– 18.0 to – 3.7) |
| MAP (mm Hg) | 84.5 (75.7–90.2) | 78.5 (75.0 to 85.5) | <b>&lt;0.001</b> | 0.60     | – 5.2 (– 9.9 to 2.0)     |
| PRx (a.u.)  | 0.23 (0.02–0.34) | 0.43 (0.24 to 0.51) | <b>&lt;0.001</b> | 0.61     | 0.31 (0.1 to 0.40)       |

# Extracorporeal membrane oxygenation use in patients with traumatic brain injury

Perfusion  
2015, Vol. 30(5) 407–409

## ECMO

**M Biscotti,<sup>1</sup> WD Gannon,<sup>2</sup> D Abrams,<sup>2</sup> C Agerstrand,<sup>2</sup> J Claassen,<sup>3</sup>  
D Brodie<sup>2</sup> and M Bacchetta<sup>4</sup>**

- Kazuistiky
- Antikoagulační léčba





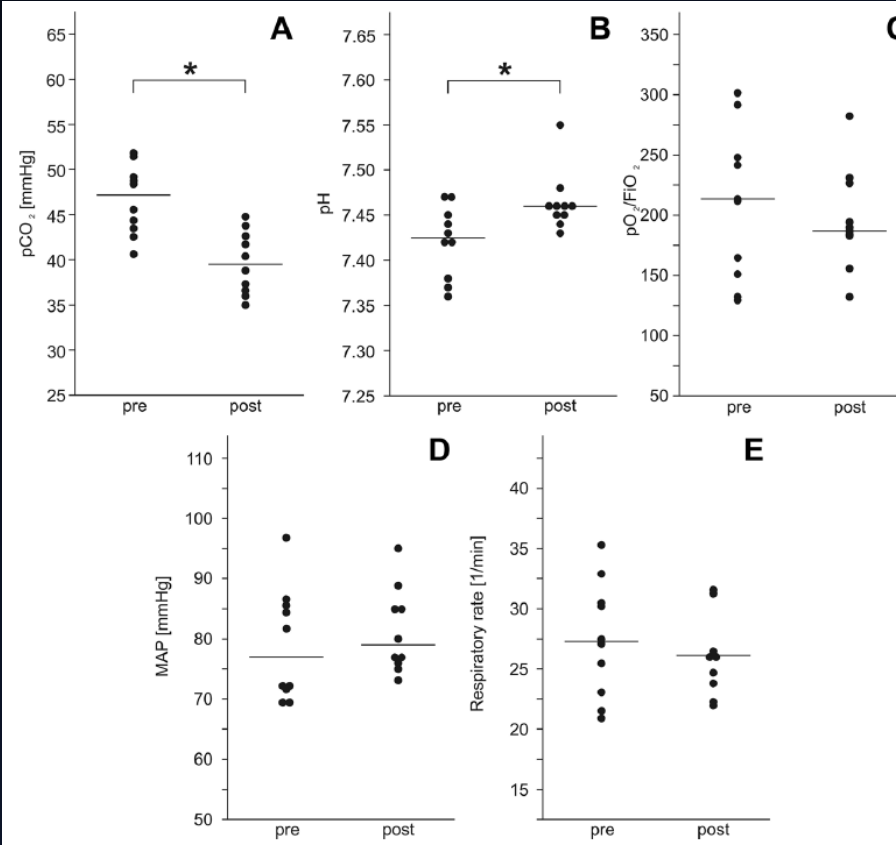
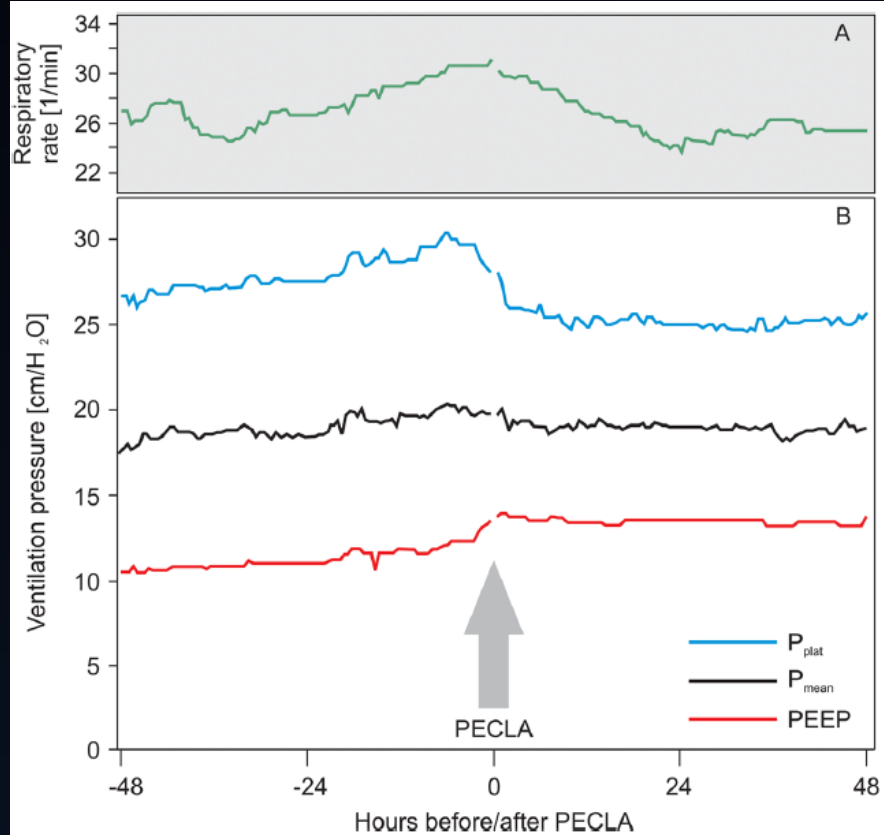
RESEARCH

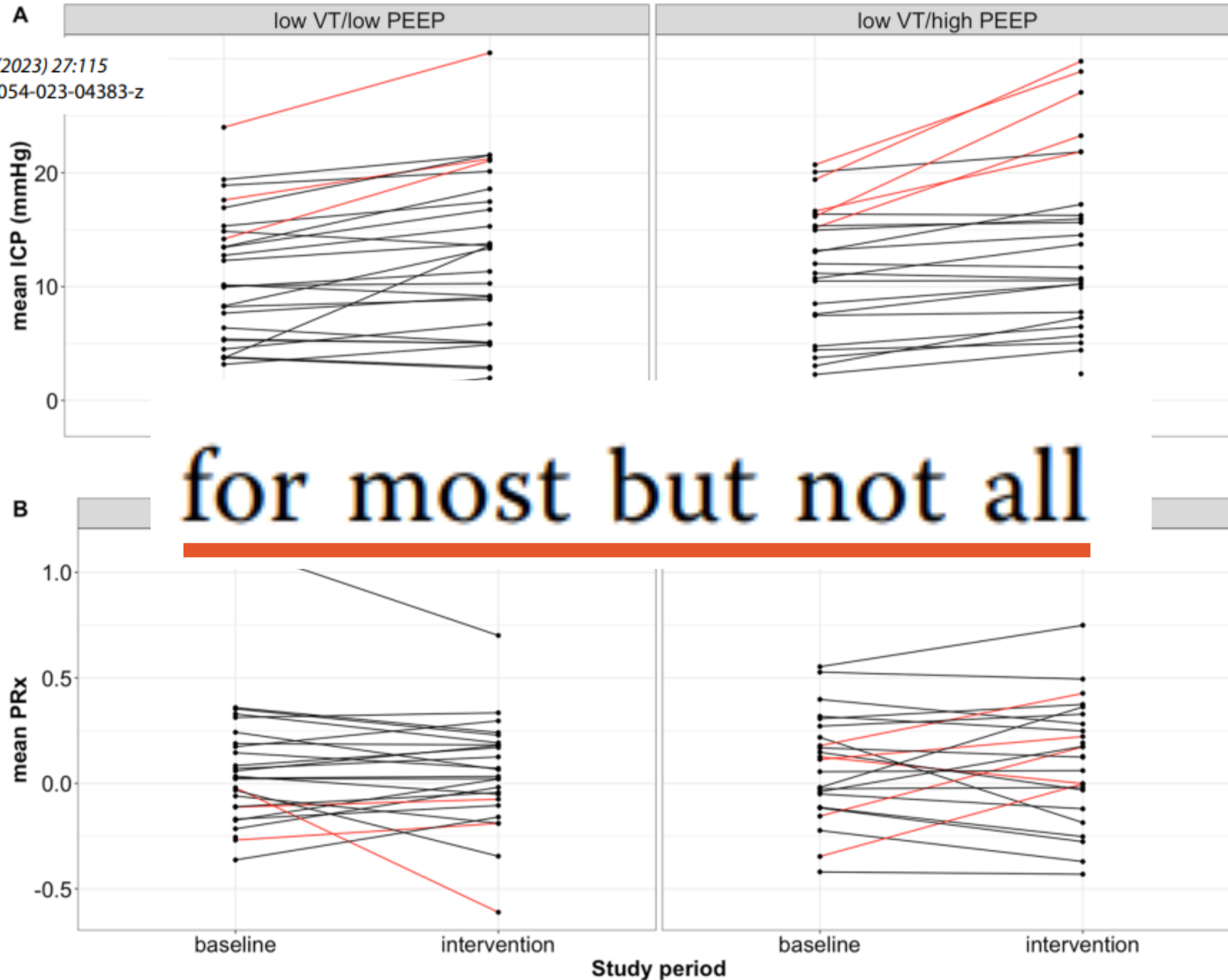
Open Access



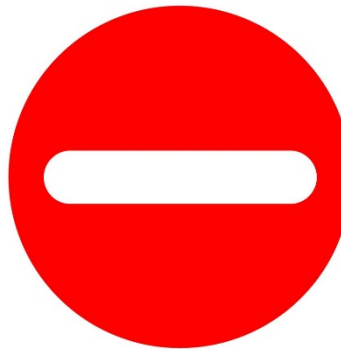
# Extracorporeal decarboxylation in patients with severe traumatic brain injury and ARDS enables effective control of intracranial pressure

Christopher Munoz-Bendix<sup>1</sup>, Kerim Beseoglu<sup>1</sup> and Rainer Kram<sup>2\*</sup>





~~25%~~



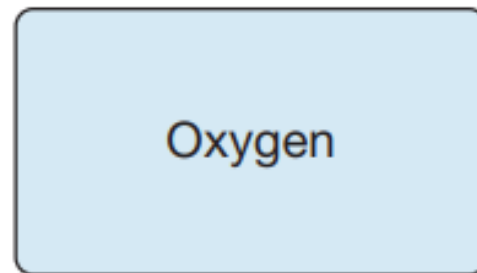
## Neurologic Treatments

## Pulmonary Treatments

↑O<sub>2</sub>  
↑MAP



Oxygen



↑PEEP

Low volume vent

Proning

Sedation

Paralysis

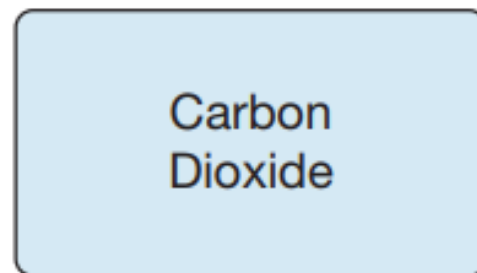
Inhaled vasodilators

ECMO

Transient  
hyperventilation



Carbon  
Dioxide

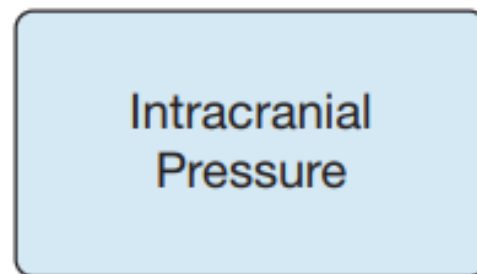


Low volume vent

Sedation  
Paralysis  
Hyperosmolar  
EVD  
Craniectomy



Intracranial  
Pressure



↑PEEP

Proning

CHEST 2022; 161(1):140-151

### Lung Protective Ventilation (LPV)

- Permissive hypercapnia can  $\uparrow$ CBF,  $\uparrow$ CBV and cause  $\uparrow$ ICP
- Standard ARDS  $P_{aO_2}$  goal (55-80mmHg) likely too low for SABI
- $\uparrow$ sedation to tolerate LPV
- Avoid hypercapnia, target  $P_{aCO_2}$  35-45mmHg
- If  $\uparrow P_{aCO_2}$  and concern for  $\uparrow$  ICP: invasive ICP/PbtO<sub>2</sub> monitor to individualize  $P_{aCO_2}$  target; treat  $\uparrow$  ICP;  $\uparrow$  MAP to CPP 60-70 mmHg
- $P_{aO_2}$  target: 80-120mmHg

### Prone Positioning (PP)

- $\downarrow$ HOB,  $\uparrow$ abdominal pressure, and  $\downarrow$ cerebral venous outflow  $\rightarrow$   $\uparrow$ ICP
- Neuro exam limited
- ICP monitor displacement
- Inadequate CSF drainage during PP
- If concern for  $\uparrow$ ICP: place ICP/PbtO<sub>2</sub> monitor; pre-treat ICP prior to position changes
- $\uparrow$  MAP to CPP 60-70 mmHg reverse Trendelenburg offload abdominal pressure
- Modify prone angle for neuro exam

### Positive End Expiratory Pressure (PEEP)

- PEEP causes  $\uparrow$ ITP/RAP and  $\downarrow$ jugular venous outflow, thus may  $\uparrow$ ICP
- PEEP can  $\downarrow$ MAP and cause  $\downarrow$  CPP
- Position to  $\uparrow$ jugular venous outflow
- Avoid lung hyperinflation
- Keep MAP > 65 mmHg
- Utilize non-invasive ICP monitoring, autoregulation studies

### Inhaled Pulmonary Vasodilators

- Theoretical  $\downarrow$ platelet function can cause ICH expansion
- If concern for bleeding, monitor clinically and radiographically

### Sedation and Neuromuscular Blockade (NMB)

- May limit neuro exam
- Sedation pauses can  $\uparrow$ ICP (when concern for cerebral edema)
- Prefer short acting sedatives
- Assess need for ICP control with sedation/NMB
- Monitor  $P_{aCO_2}$  when initiating NMB
- Multimodal monitoring to assess for neuro worsening

### Venovenous Extracorporeal Membrane Oxygenation (VV-ECMO)

- $\uparrow$ ICH risk: therapeutic anticoagulation, circuit-induced coagulopathy, platelet dysfunction
- Jugular cannula can  $\downarrow$  jugular venous outflow and  $\uparrow$ ICP
- Rapid  $P_{aCO_2}$  fluctuations can affect cerebral perfusion, cause ICH,  $\uparrow$  ICP
- Weigh risks and benefits, projected neuro outcome case-by-case
- Consider Femoral-Femoral configuration to avoid jugular cannula
- Consider AC-free ECMO if concern for ICH, hemorrhagic conversion
- Consider pECLA for  $P_{aCO_2}$  management

### Conservative Fluid Strategy

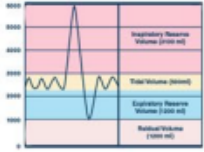
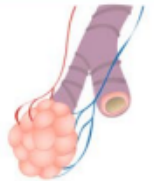
- Hypotension, hypovolemia can  $\downarrow$  cerebral perfusion  $\rightarrow$  brain ischemia
- $\uparrow$  risk in vasospasm, cerebral/cervical vascular stenosis or occlusion
- Serial volume assessments
- Coupled neuro-hemodynamic monitoring
- Avoid hypotension
- target intravascular euvolemia

### Steroids

- Unclear which populations may benefit or be harmed
- $\uparrow$  mortality in TBI
- $\uparrow$  risk of critical illness neuropathy/myopathy
- Weigh risks and benefits case-by-case
- Limit use in patients with TBI



# What respiratory targets should be recommended in patients with brain injury and respiratory failure?

| <b>Ventilatory strategies</b><br>          | <b>VT</b><br>                                                                     | <b>PEEP</b><br>                                                      | <b>RM</b><br>               | <b>Prone Position</b><br> | <b>ECMO</b><br>                                                              | <b>Ventilatory Targets</b><br>                                                          |
|-----------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>ABI</b><br>                             | <ul style="list-style-type: none"> <li>• Low evidence</li> <li>• VT 6-9 ml/kg PBW</li> <li>• Pplat&lt;30 cmH<sub>2</sub>O</li> </ul>                               | <ul style="list-style-type: none"> <li>• Low evidence</li> <li>• Could impair venous return</li> <li>• Hyperinflation can cause hypercapnia</li> </ul> | <ul style="list-style-type: none"> <li>• No evidence</li> <li>• Might increase ICP</li> </ul>                  | <ul style="list-style-type: none"> <li>• No evidence</li> <li>• Might increase ICP</li> </ul>                | <ul style="list-style-type: none"> <li>• No evidence</li> </ul>                                                                                                 | <ul style="list-style-type: none"> <li>• PaO<sub>2</sub>&gt;75 mmHg</li> <li>• Normocapnia</li> <li>• PaCO<sub>2</sub>&lt;30 mmHg not recommended</li> </ul>               |
| <b>ARDS</b><br>                           | <ul style="list-style-type: none"> <li>• Strong recommendation</li> <li>• VT 6-ml/kg PBW</li> <li>• Pplat&lt;30 cmH<sub>2</sub>O</li> </ul>                        | <ul style="list-style-type: none"> <li>• FIO<sub>2</sub>/PEEP table ARDS network</li> </ul>                                                            | <ul style="list-style-type: none"> <li>• Conditional recommendation</li> </ul>                                 | <ul style="list-style-type: none"> <li>• Strong recommendation if severe</li> </ul>                          | <ul style="list-style-type: none"> <li>• Might be used as rescue therapy</li> </ul>                                                                             | <ul style="list-style-type: none"> <li>• PaO<sub>2</sub>55-80 mmHg</li> <li>• Any PaCO<sub>2</sub> if pH&gt;7.25</li> </ul>                                                |
| <b>Final Recommendation ABI+ARDS</b><br> | <ul style="list-style-type: none"> <li>• Protective VT</li> <li>• Individualize VT according to PL and DP</li> <li>• Increase RR to prevent hypercapnia</li> </ul> | <ul style="list-style-type: none"> <li>• Individualize PEEP based on cerebral and lung compliance</li> <li>• Avoid hyperinflation</li> </ul>           | <ul style="list-style-type: none"> <li>• Only on a case-by-case basis and guided by neuromonitoring</li> </ul> | <ul style="list-style-type: none"> <li>• Could be considered</li> <li>• Use neuromonitoring</li> </ul>       | <ul style="list-style-type: none"> <li>• Only in specific cases as rescue therapy when conventional treatment fails</li> <li>• Consider heparin dose</li> </ul> | <ul style="list-style-type: none"> <li>• PaO<sub>2</sub>&gt;75 mmHg</li> <li>• Protective ventilation</li> <li>• Normocapnia or based on neuromonitoring and pH</li> </ul> |



ICM 2020

*no evidence; good practice statement*

Strong recommendation

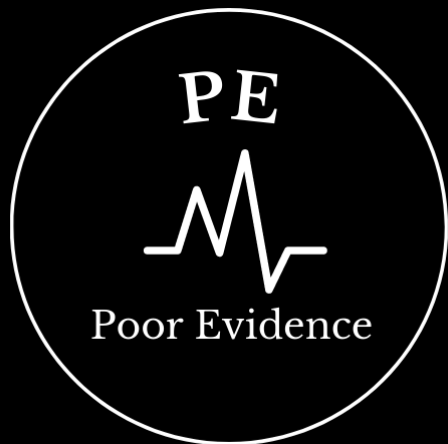
Weak recommendation

No recommendation

## CONFERENCE REPORTS AND EXPERT PANEL



# Mechanical ventilation in patients with acute brain injury: recommendations of the European Society of Intensive Care Medicine consensus



**We are unable to provide any recommendations**

**We recommend**

**We suggest**

Low evidence in favor

No evidence

Very low evidence in favor

# 1. What are the indications for endotracheal intubation in patients with ABI?

- Vědomí, agitace, reflexy, ICP
- GCS < 8
- ICP, herniace
- Bulbární
- Plicní indikace

## 2. Is it safe and effective to use non-invasive respiratory support in patients with ABI?

- ?
- NIV
- HFOT

### 3. Should we use specific mechanical ventilation settings in patients with ABI?

- 0 ARDS = +ICP
  - Standard
- + ARDS/ = ICP
  - lung protective
- 0 ARDS/+ICP, +ARDS/+ICP,
  - ? Lung protective

#### 4. Should we target specific values of partial pressure of oxygen ( $\text{PaO}_2$ ) and partial pressure of carbon dioxide ( $\text{PaCO}_2$ ) in patients with ABI?

##### *Oxygen levels*

- = ICP/ + ICP
  - 80 -120 mmHg

##### *$\text{PaCO}_2$ and short-term hyperventilation*

- =ICP
  - 35- 45mmHg
  - Krátkodobá hyperventilace

## 5. Is it safe and effective to use rescue interventions to support severe respiratory failure in patients with ABI?

- ? Recruitment +/- ICP

*Alveolar recruitment maneuvers*

- ARDS +/- ICP ?

*Prone positioning*

- ARDS +/- ICP +

- ? NM RD

*Neuromuscular blockers*

- ?

*Extracorporeal life support*

## 6. What are the criteria for ventilator weaning and extubation in patients with ABI?

### 1. What are the indications for endotracheal intubation in patients with ABI?

- Vědomí, agitace, reflexy, ICP
- GCS < 8
- ICP, herniace
- Bulbární
- Plicní indikace

(ANESTHESIOLOGY)

## 7. What are the indications for and optimal timing of tracheostomy in patients with ABI?

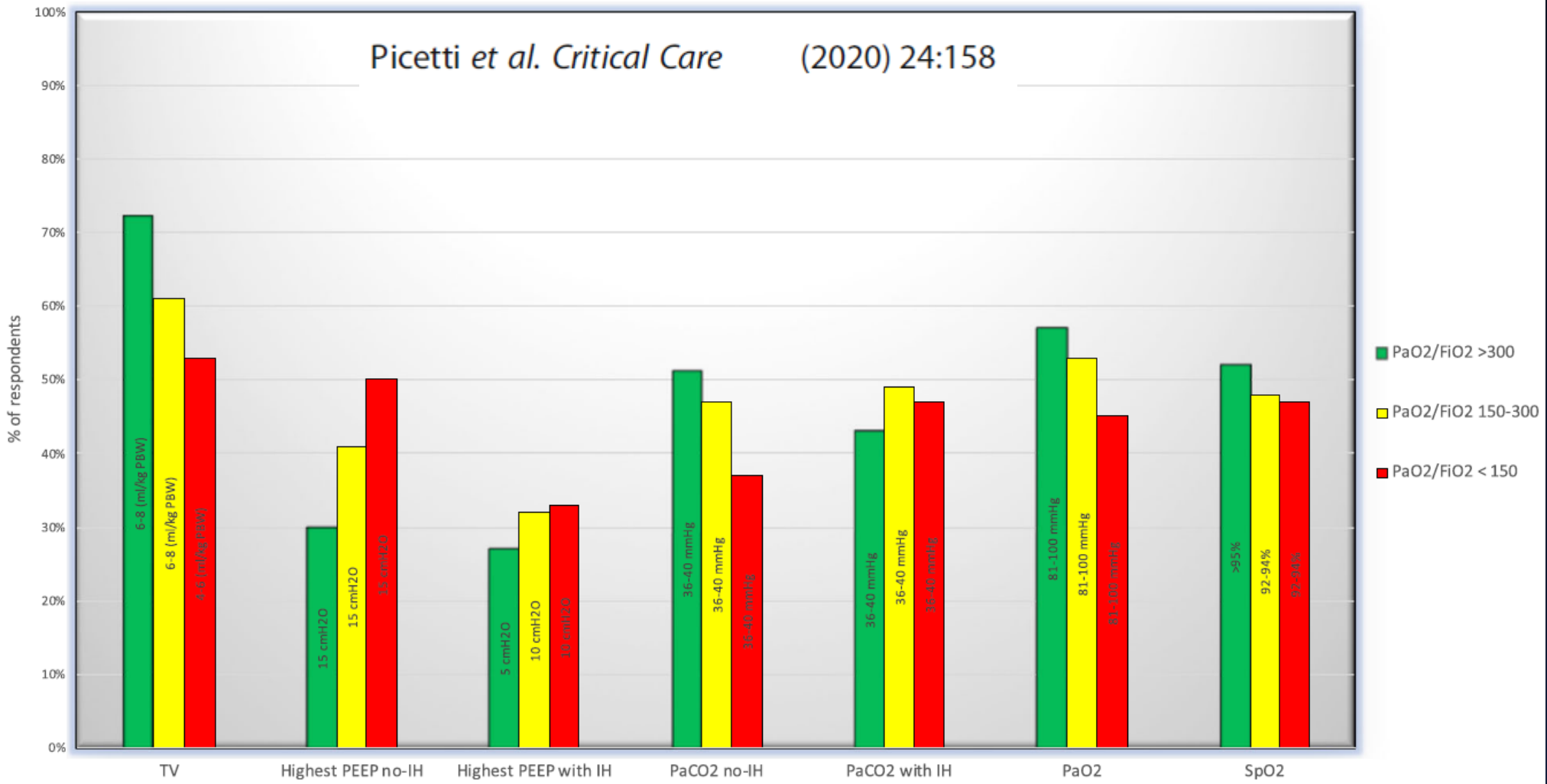
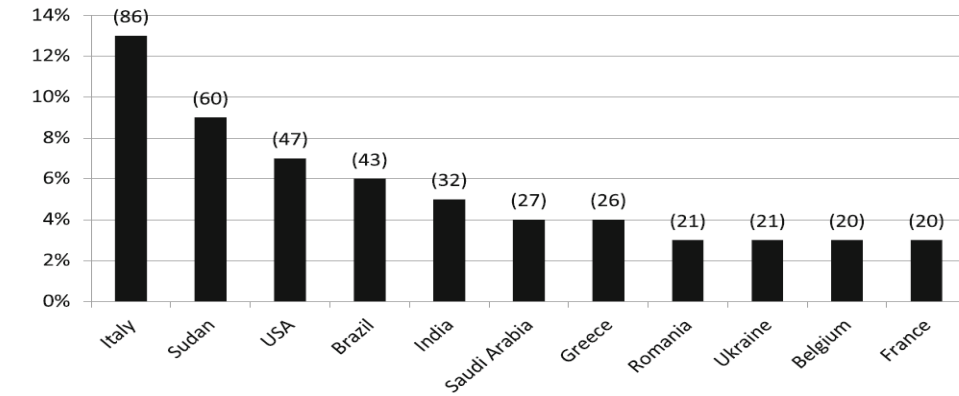
- Několik selhavších extubací
- Bezvědomí

*Indications for tracheostomy*

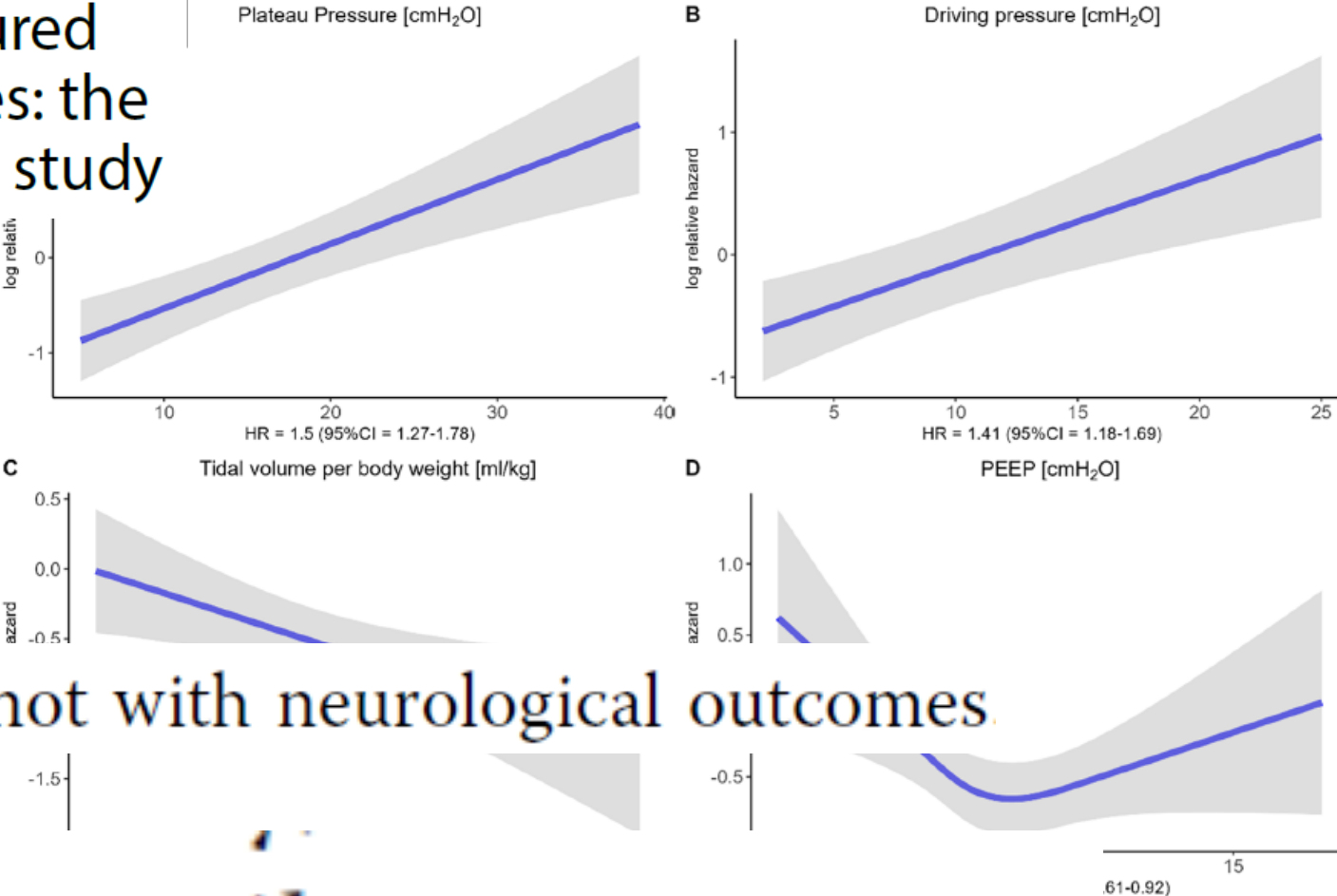
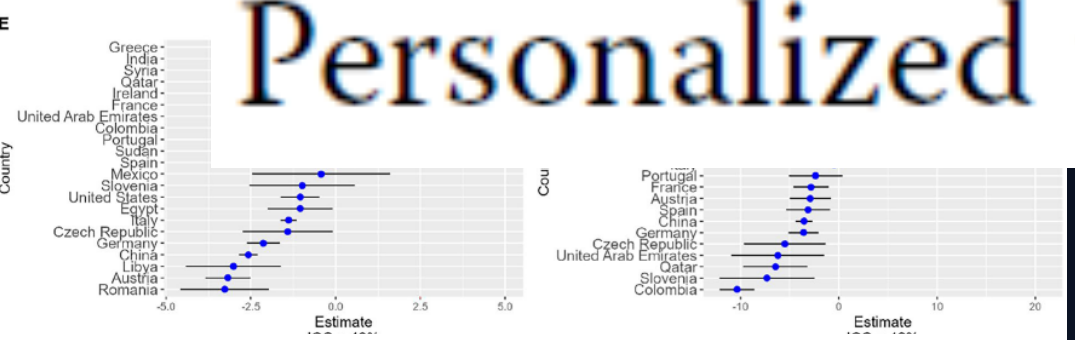
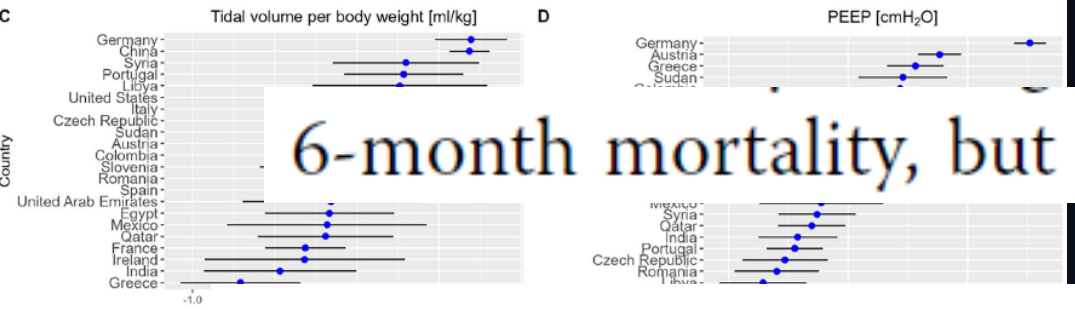
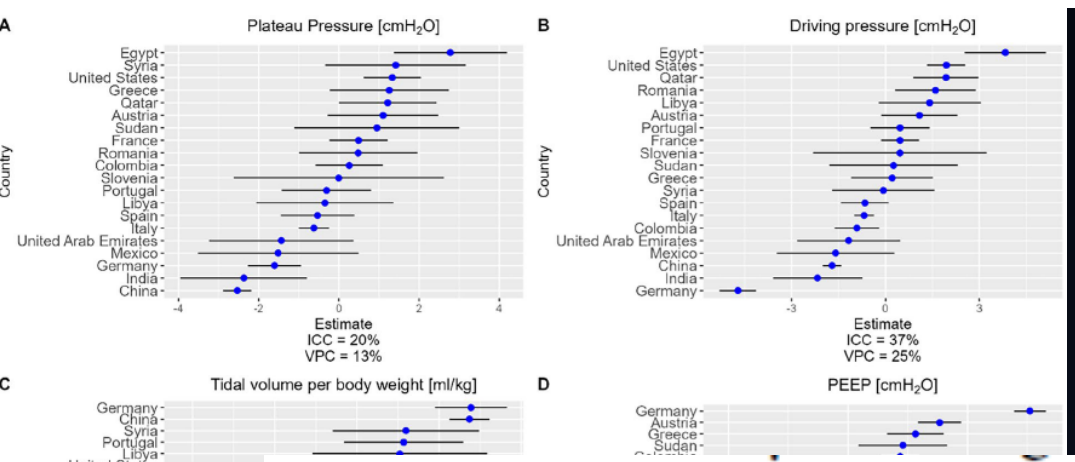
### *Timing of tracheostomy*

The panel noted that the decision regarding timing of tracheostomy varies considerably across countries and medical institutions and may depend considerably on local practices and policies. Therefore, the panel **did not reach a consensus.**

# VENTILatOry strategies in patients with severe traumatic brain injury: the VENTILO Survey of the European Society of Intensive Care Medicine (ESICM)



# Ventilation practices in acute brain injured patients and association with outcomes: the VENTIBRAIN multicenter observational study

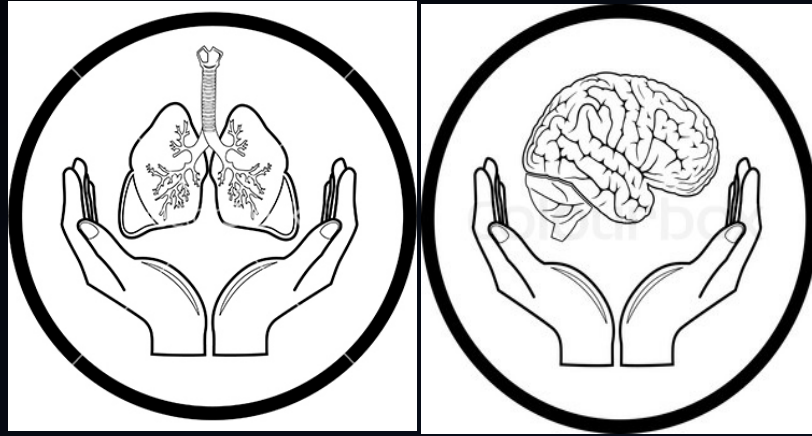


6-month mortality, but not with neurological outcomes

# Personalized ventilatory targets

Received: 15 November 2024 Accepted: 19 January 2025  
Published: 24 February 2025

# Ventilace



## NESMÍ/BY NEMĚLA:

- Ovlivňovat hemodynamiku
  - Systémovou
    - $MAP = CO \times SVR$



## MUSÍ/BY MĚLA

- Zajistit
  - Kontrolu  $CO_2$  a pH
  - Oxygenaci
- Mozkovou hemodynamiku
  - CBF
  - $ICP \text{ CPP} = MAP - ICP$



# Mechanical ventilation in neurocritical care setting: A clinical approach

D. Battaglini, D. Siwicka Gieroba, I. Brunetti et al.

Best Practice & Research Clinical Anaesthesiology 35 (2021) 207–220

## BRAIN INJURY

## MV SETTING

- Intubation for GCS  $\leq 8$
- PaCO<sub>2</sub> between 35–45 mmHg. Hyperventilation should be considered for 15–30 minutes

## Conclusions

In summary, ventilatory management, weaning, and tracheostomy for the main subpopulations of neurocritical care patients is **similar to the general population**, although specific recommendations and evidences should be taken into account for each specific subgroup, to minimize the risk of respiratory complications and cerebral dysfunction.

## SAH

## ICH

Indication for mechanical ventilation in aneurysmal and ruptured aneurysm: GCS  $\leq 8$ , GCS  $< 2$  points, optimization of MV and oxygenation, seizures control, airway protection in absence of reflexes

- Follow the previous suggestions for V<sub>T</sub>, PEEP, PaO<sub>2</sub>
- VISAGE score for tracheostomy

- Intubation for GCS  $\leq 8$
- VT 6–8 mL/kg of PBW
- PEEP titrated for oxygenation
- TRACH score for tracheostomy





Pavel Dostál

„Co je dobré pro mozek je  
dobré i pro plíce?“

