mechanical ventilation in patients with sepsis

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Kurzinfo

Heidelberg ist eine Großstadt in Baden-Württemberg im Südwesten Deutschlands, unweit der Mündung des Neckars in den Rhein. [Wikipedia]

Bevölkerung: 150.335 (2013)
Fläche: 108,8 km²
Gebirgend: 1106

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conflict of interest

consultant, travel expenses, lecture fees
What is your focus for a patient on the ventilator?

- Oxygenation
- CO₂ Elimination
- Lung protection
Best practice in mechanical ventilation?

- **$V_T$:** 6 ml/kg pbw for all patients?
  - NEJM 2000

- **PEEP:** ARDS network table based on Oxygenation?
  - NEJM 2000 or NEJM 2004

- **High PEEP:** for severe ARDS
  - JAMA 2010

- **Prone:** for severe ARDS
  - NEJM 2013

- **NMB:** for severe ARDS
  - NEJM 2010

- **No NIV** for severe ARDS
  - AJRCCM 2017
WHAT’S NEW IN INTENSIVE CARE

What’s new in mechanical ventilation in patients without ARDS: lessons from the ARDS literature

Ary Serpa Neto¹,²,³ and Samir Jaber⁴*

EDITORIAL

What’s new in ARDS: can we prevent it?

Roy G. Brower¹ and Massimo Antonelli²*
ARDS and Sepsis
ARDS and Sepsis
ARDS and Sepsis
How often is ARDS in severe sepsis?
Fig. 2  Frequency of acute respiratory distress syndrome (ARDS) development according to amount of fluid administered during the first 6 h of hospital presentation.
Best practice in mechanical ventilation?

- **VT**: 6 ml/kg pbw for all patients?
  - NEJM 2000
- **PEEP**: ARDS network table based on Oxygenation?
  - NEJM 2000 or NEJM 2004
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Normalisation because of unknown size of the „baby“ lung

Driving Pressure and Survival in the Acute Respiratory Distress Syndrome

Marcelo B.P. Amato, M.D., Maureen O. Meade, M.D., Arthur S. Slutsky, M.D., Laurent Brochard, M.D., Eduardo L.V. Costa, M.D., David A. Schoenfeld, Ph.D., Thomas E. Stewart, M.D., Matthias Briel, M.D., Daniel Talmor, M.D., M.P.H., Alain Mercat, M.D., Jean-Christophe M. Richard, M.D., Carlos R.R. Carvalho, M.D., and Roy G. Brower, M.D.

Because respiratory-system compliance ($C_{RS}$) is strongly related to the volume of aerated remaining functional lung during disease (termed functional lung size), we hypothesized that driving pressure ($\Delta P = V_T / C_{RS}$), in which $V_T$ is intrinsically normalized to functional lung size (instead of predicted lung size in healthy persons),
tidal volume should not longer be the target!
Oxygen Exposure Resulting in Arterial Oxygen Tensions Above the Protocol Goal Was Associated With Worse Clinical Outcomes in Acute Respiratory Distress Syndrome

- Goal partial pressure of oxygen in arterial blood range of 55–80 mm Hg
- $f_iO_2$ of 0.5 = 0
- Increasing deaths with higher oxygenation in all groups of ARDS severity
Oxygenation should not be the key parameter for the ventilator settings!
alveolar stability is unrelated to arterial oxygenation
Association Between Partial Pressure of Arterial Carbon Dioxide and Survival to Hospital Discharge Among Patients Diagnosed With Sepsis in the Emergency Department

Odds Ratio to hospital discharge

rise in CO₂ of 1 mmHg

with a 3% increase in odds of survival
The Rivers protocol

1. stratify according to severity

2. measure relevant parameter

3. individualize therapy
Personalizing mechanical ventilation according to physiologic parameters to stabilize alveoli and minimize ventilator induced lung injury (VILI)

Gary F. Nieman, Joshua Satalin, Penny Andrews, Hani Aiash, Nader M. Habashi and Louis A. Gatto
1. End-expiratory lung volume (EELV) at a given PEEP

2. Transpulmonary pressure gradient

\[(\text{P}_{\text{plat}} - \text{P}_{\text{oes/El}}) - (\text{PEEP} - \text{P}_{\text{eos/EE}})\]
baby lung size ≈ EELV
Why oxygenation is not a good target

Kalenka et al, unpublished data
Tidal volume of 420 ml based on kg iBW at different FRC (EELV)

dynamic strain = $V_T/EELV$
Lung strain and biological response in mechanically ventilated patients

Dynamic strain = \( \frac{V_T}{EELV} \)

Aim for dynamic strain < 0.25
Assessing alveolar recruitment by EELV

Compliance=30 ml/cmH2O
EELV= 1000 ml

No recruitment
EELV= 1300 ml

Expected EELV increase:
30 * 10 = 300 ml

PEEP = 0

PEEP=10

Courtesy of Antonio Pesenti
Strain: „the driving pressure“
\[ V_T / EELV \neq V_T / ml/iKG \]

Stress:
\[ P_{TP} \neq P_{AW} \]

\[ \text{Stress} = k \times \text{Strain} \]
\[ k = \text{Specific Elastance} \left( E_{L,s} \right) = \text{Stress} / \text{Strain} \]

Specific Elastance = 13 – 15 cmH₂O
Individualized titration of PEEP and $V_T$

$P_{pulm.} = P_{alv} - P_{pl} \sim P_{oes}$
optimize PEEP and $V_T$

with measurement of esophageal pressure and transpulmonary pressure gradient

1. PEEP > endexspiratory esophageal pressure

2. $V_{T,max} = \text{transpulmonary pressure gradient} < 10$ (20)

   $$(P_{\text{plat}} - P_{\text{oes/El}}) - (\text{PEEP} - P_{\text{eos/EE}})$$
$V_T$ and PEEP?

- **Male**
- **172 cm**
- **86 kg**
- **EF 20%**
- **Respiratory distress**

- **High dose vasopressor**
- $f_{O_2} 0.9$
- $S_{pO_2} 88\%$
3000 ml
1500 ml
1000 ml
500 ml
0 ml

13 cmH2O
15 cmH2O
17 cmH2O
19 cmH2O
21 cmH2O

400/2000 = 0.2
400/1600 = 0.25

FRC INview
PEEP INview

FRC O2 100%

Start PEEP 20 cmH2O
End PEEP 14 cmH2O
Messerungen 3
Niveaudauer 10 min

Geschützte Zeit ---- min

Lung INview

Leckage-Kompens. EIN

Aktueller Modus BiLevel-VG

FIO2 90 %
VT 400 ml
Frequenz 22 /min
Tinsp 1.0 s
PEEP 18 cmH2O
PS 8 cmH2O

Paw 60 cmH2O
Pmax
Ppeak

VTexsp 398 ml
FiO2 91 %

12:34
TPP = (35 - 26) - (20 - 18) = 9 - 2 = 7
Friday night ventilation: a safety starting tool kit for mechanically ventilated patients

L. GATTINONI 1, 2, E. CARLESSO 2, L. BRAZZI 3, 4, M. CRESSONI 2
S. ROSSEAU 5, S. KLUGE 6, A. KALENKA 7, M. BACHMANN 8, L. TOEPFER 9
H. WRIGGE 10, F. REDAELLI 11, C. VETTER 12, M. WYSOCKI 13

„Friday night“ Minerva Anestesiologica 2014; 80: 1046
Set the ventilator:
- PEEP 10 cmH₂O
- I:E 1:1 or 1:2
- TV 6 ml/kg IBW
- RR 15 RPM,
- FiO₂ 0.6-0.8.

Control central venous blood gases and Lactate for hemodynamic status

1. BiLevel-VG

2. TV: 6 ml/kg IBW (Worldwide accepted)
   - Consider STRAIN thresholds and normalize TV on FRC (if available) rather than IBW
   - Pplat < 30cmH₂O
     - YES: Accept TV 6 ml/kg IBW
     - NO: SEVERE ARDS
       - Measure esophageal pressure or bladder pressure
       - Is Ccw normal?
         - NO: Accept Pplat >30cmH₂O
         - YES: Reduce PEEP or TV or accept Hypercapnia

Moderate Recruitment decremental PEEP InView

11:00 PM FRIDAY

11:30 PM FRIDAY
Lung-Protective Ventilation Initiated in the Emergency Department (LOV-ED): A Quasi-Experimental, Before-After Trial

BILEVEL 34/18 mbar
VT 6,1 ml/kg
AF 18/min
FiO₂ 1.0
P/F 67 mmHg
PCO₂ 78 mmHg

BILEVEL 42/32 mbar
VT 5,7 ml/kg
AF 18/min
FiO₂ 0.4
P/F 244 mmHg
PCO₂ 38 mmHg
Résumé

It’s a passion, not just a profession