Ventilazione non-invasiva e COVID-19

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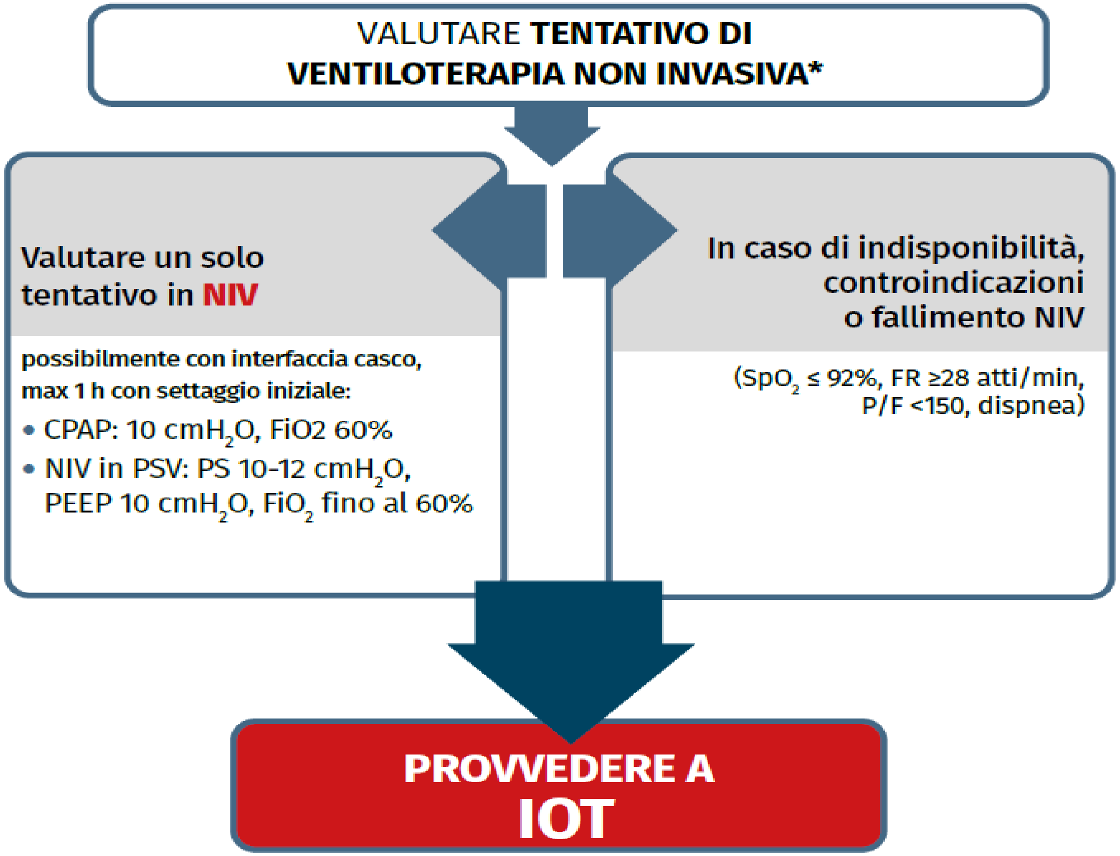
Intensive Care Med (2020) 46:315–328
https://doi.org/10.1007/s00134-020-05943-5

NARRATIVE REVIEW

Critical care management of adults with community-acquired severe respiratory viral infection

Yaseen M. Arabi[1,2,3*], Robert Fowler[4,5,6] and Frederick G. Hayden[7]

Based on available evidence, NIV in severe RVI may be used in selected patients in early stages and milder forms of acute hypoxemic respiratory failure, excluding those in shock or multiorgan failure, with the recognition that for patients who do not show signs of early recovery, NIV may well delay but not avoid invasive ventilation [42].



* VALUTARE **TENTATIVO IN OSSIGENOTERAPIA AD ALTO FLUSSO (HFNO)**
se disponibile e se paziente isolato in ambiente a pressione negativa, in assenza di immediata tecnica alternativa:

- FLUSSO *almeno* 50lt/min
- FIO$_2$ *almeno* 60%

SIAARTI
PRO VITA CONTRA DOLOREM SEMPER

Intensive Care Med
https://doi.org/10.1007/s00134-020-06022-5

GUIDELINES

Surviving Sepsis Campaign: guidelines on the management of critically ill adults with Coronavirus Disease 2019 (COVID-19)

VENTILATION		
23	In adults with COVID-19, we ***suggest*** starting supplemental oxygen if the peripheral oxygen saturation (SpO_2) is < 92%, and ***recommend*** starting supplemental oxygen if SpO_2 is < 90%	Weak Strong

24	In adults with COVID-19 and **acute hypoxemic respiratory failure on oxygen**, we ***recommend*** that SpO_2 be maintained no higher than 96%	Strong
25	For adults with COVID-19 and **acute hypoxemic respiratory failure** despite conventional oxygen therapy, we ***suggest using*** HFNC over conventional oxygen therapy	Weak
26	In adults with COVID-19 and **acute hypoxemic respiratory failure**, we ***suggest*** using HFNC over NIPPV	Weak
27	In adults with COVID-19 and **acute hypoxemic respiratory failure**, if HFNC is not available and there is no urgent indication for endotracheal intubation, we ***suggest*** a trial of NIPPV with close monitoring and short-interval assessment for worsening of respiratory failure	Weak
28	**We were not able to make a recommendation** regarding the use of helmet NIPPV compared with mask NIPPV. It is an option, but we are not certain about its safety or efficacy in COVID-19	No recommendation
29	In adults with COVID-19 receiving NIPPV or HFNC, we ***recommend*** close monitoring for worsening of respiratory status, and early intubation in a controlled setting if worsening occurs	Best practice statement

Official ERS/ATS clinical practice guidelines: noninvasive ventilation for acute respiratory failure

Eur Respir J 2017; 50: 1602426

TABLE 2 Recommendations for actionable PICO questions

Clinical indication#	Certainty of evidence¶	Recommendation
Prevention of hypercapnia in COPD exacerbation	⊕⊕	Conditional recommendation against
Hypercapnia with COPD exacerbation	⊕⊕⊕⊕	Strong recommendation for
Cardiogenic pulmonary oedema	⊕⊕⊕	Strong recommendation for
Acute asthma exacerbation		No recommendation made
Immunocompromised	⊕⊕⊕	Conditional recommendation for
De novo respiratory failure		No recommendation made
Post-operative patients	⊕⊕⊕	Conditional recommendation for
Palliative care	⊕⊕⊕	Conditional recommendation for
Trauma	⊕⊕⊕	Conditional recommendation for
Pandemic viral illness		No recommendation made
Post-extubation in high-risk patients (prophylaxis)	⊕⊕	Conditional recommendation for
Post-extubation respiratory failure	⊕⊕	Conditional recommendation against
Weaning in hypercapnic patients	⊕⊕⊕	Conditional recommendation for

#: all in the setting of acute respiratory failure; ¶: certainty of effect estimates: ⊕⊕⊕⊕, high; ⊕⊕⊕, moderate; ⊕⊕, low; ⊕, very low.

Timenetsky *et al. BMC Research Notes* 2011, **4**:375
http://www.biomedcentral.com/1756-0500/4/375

BMC Research Notes

RESEARCH ARTICLE   Open Access

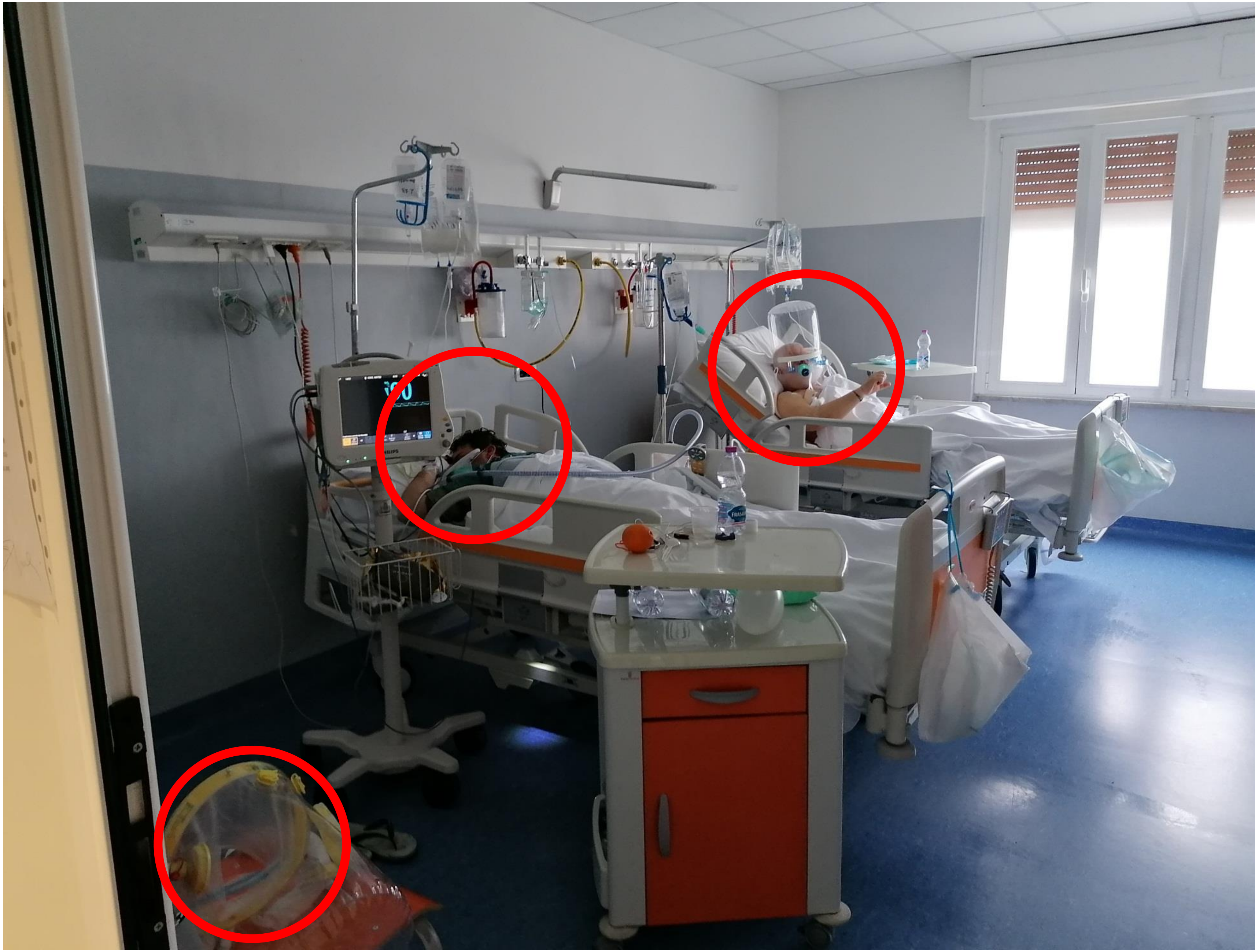
High success and low mortality rates with non-invasive ventilation in influenza A H1N1 patients in a tertiary hospital

Karina T Timenetsky*, Silvia HCT Aquino, Cilene Saghabi, Corinne Taniguchi, Claudia V Silvia, Luci Correa, Alexandre R Marra, Raquel AC Eid and Oscar FP dos Santos

Results: A total of 1, 401 cases of influenza A H1N1 were confirmed in our hospital by real-time RT-PCR in 2009, and 20 patients were admitted to the ICU. The patients' ages ranged from 18 to 74 years (median of 42). Acute Respiratory Failure (ARF) was present in 70% of patients. The median Acute Physiology and Chronic Health Evaluation II score was 7 (range 7 to 25). Of the 14 patients who developed ARF, 85.7% needed NIV and 14% needed invasive MV at admission. Our success rate (41.6%) with NIV was higher than that described by others. The hospital mortality rate was 2.1%. When influenza A H1N1 arrived in Brazil, the disease was already on endemic alert in other countries. The population was already aware of the symptoms and the health-care system of the treatment. This allowed patients to be properly and promptly treated for influenza A H1N1, while health-care workers took protective measures to avoid contamination.

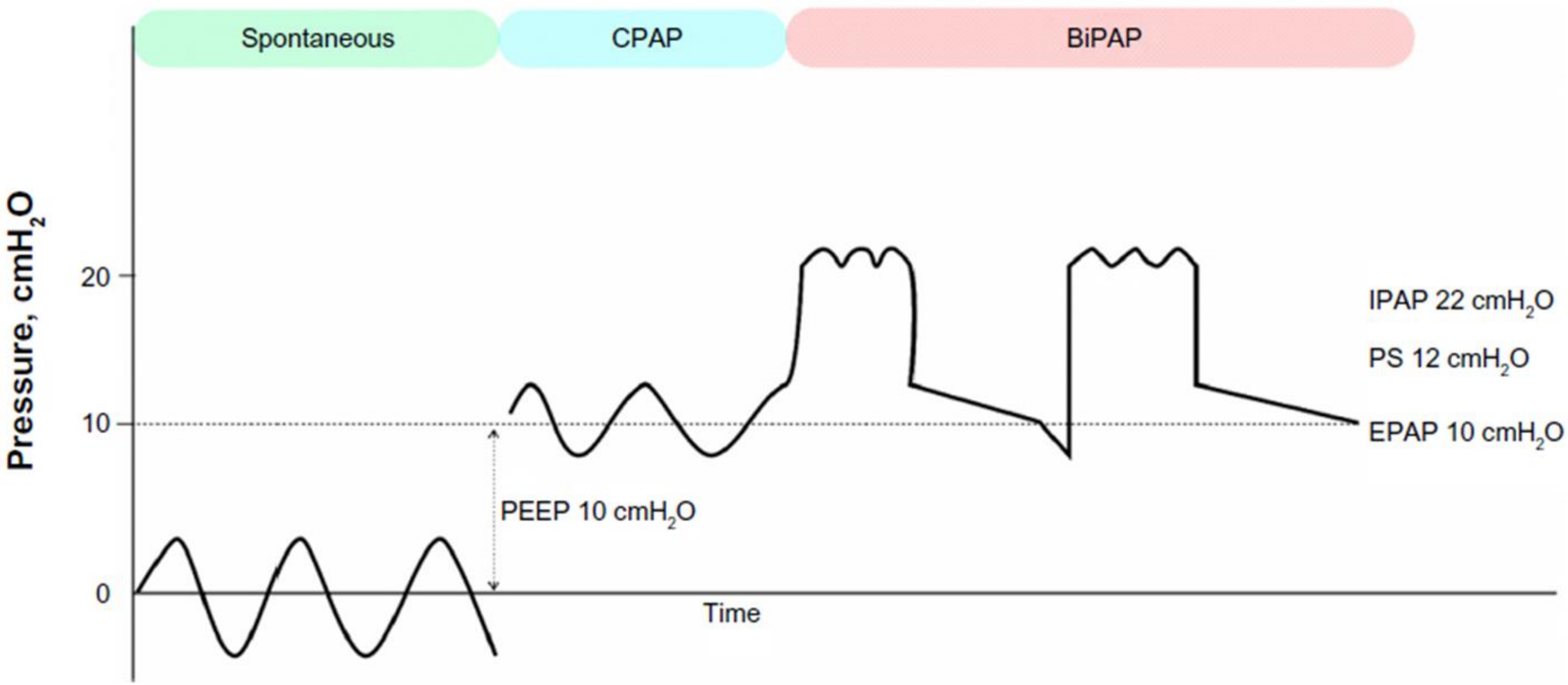
Conclusion: In our study we found a high success and low mortality rates with non-invasive ventilation in patients with influenza A H1N1.


CARTA



Non Invasive Ventilation

- C-PAP (pressione positiva continua)
- PSV (pressure support ventilation)
- HFNC (cannule nasali ad alto flusso)



BENEFITS OF NIV

1) Symptomatic relief of dyspnea

2) Correction of gas exchange

3) Improve lung mechanics

Avoid complications of ETI

VAP

Sepsis/shock

Decrease mortality

Use NIV in the place of IMV

PHYSIOLOGIC MECHANSIMS

Unload respiratory muscles inspiratory cycle:

hyperinflation >> respiratory muscle shortening/disadvantage

Decreased compliance of respiratory system

NIPPV = augments respiratory effort, Increases Vt, decreases RR

Overcome intrinsic peep

intrinsic peep>> difficulty in generating pressure gradient for flow

CPAP

Stent open lower airway expiratory cycle

CPAP to reduce obstruction

Stent open upper airway

CPAP

PHYSIOLOGIC MECHANSIMS

Reduce CO_2 production and WOB

NIPPV

Improve gas exchange by **decreasing atelectasis**

CPAP/NIPPV

Reduce negative intra-thoracic pressure swings

CPAP

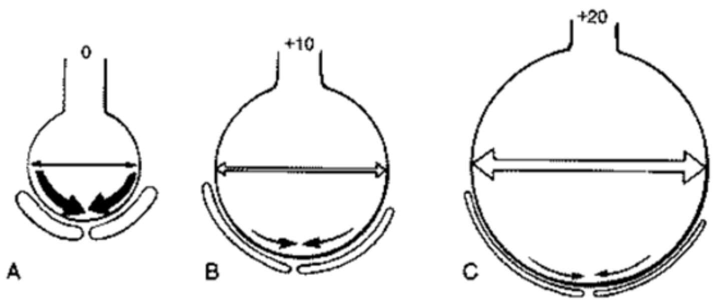
Redistribute pulmonary edema

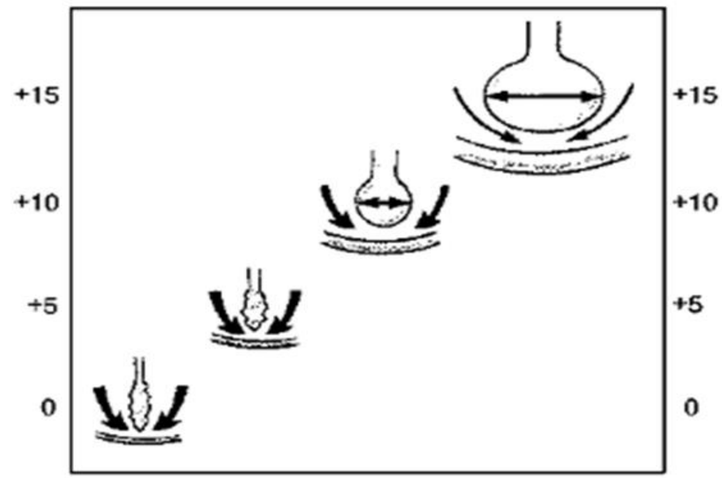
CPAP/NIPPV

Increase CO by decreasing effective LV afterload

CPAP

Increasing FRC

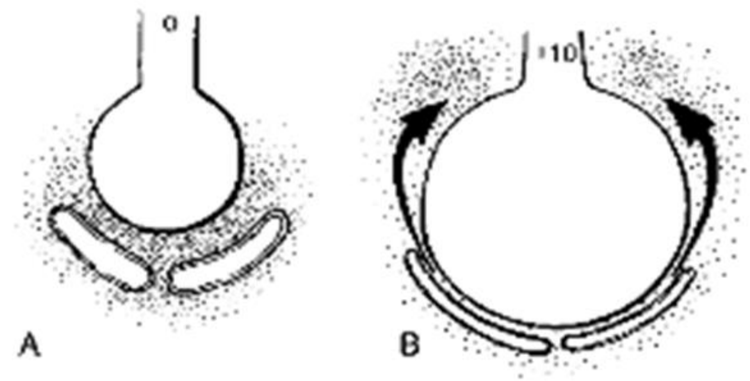




CPAP/PEEP results in an increased FRC by two distinct mechanisms:

- 10 cm H_2 O or less increases the volume of patent alveoli
- 10 cm H_2 O or more is generally responsible for alveolar recruitment
- **Increased compliance**

Redistribution of H_2O

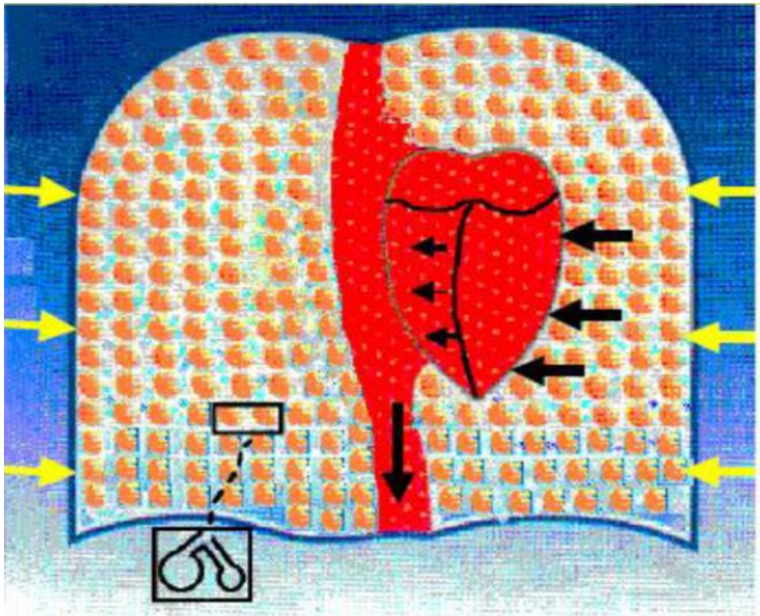


Application of CPAP/PEEP to the edematous lung

1) decreases intra-alveolar fluid volume

2) moves of water from interstitial spaces where gas exchange occurs (between the alveolar epithelium and pulmonary capillary endothelium) to the more compliant interstitial spaces (peribronchial and hilar regions)

3) Redistribution of interstitial water **improves oxygenation, lung compliance and V/Q matching.**



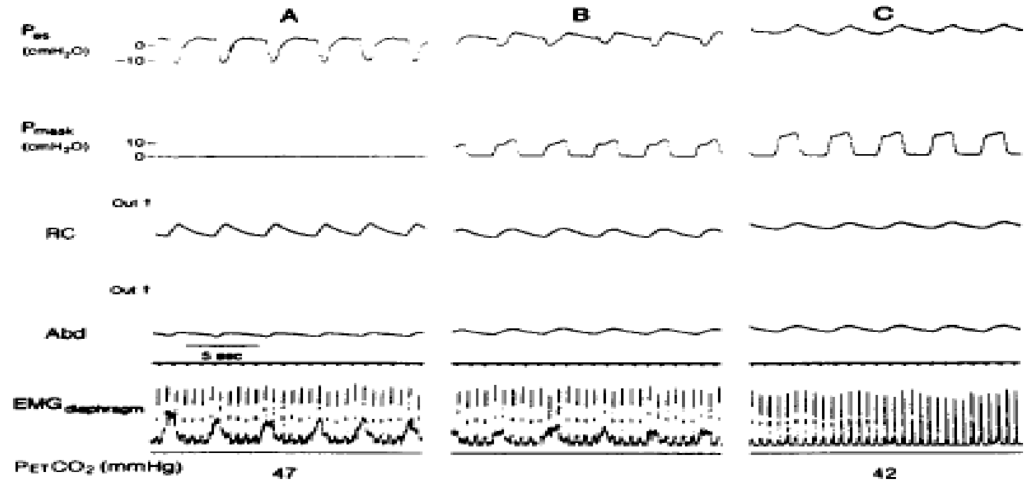


Figure 5. Tracings from a subject with COPD during spontaneous breathing (*A*) and during NPPV with mask pressure (Pmask) of 12 (B) and 15 (C) cm H_2O. NPPV reduced spontaneous inspiratory efforts as demonstrated by suppression of the phasic surface diaphragm EMG (EMGdi) and only positive inspiratory esophageal pressure (Pes) swings. The paradoxical abdominal (ABD) motion seen during spontaneous breathing (*A*) became synchronous with the rib cage (RC) during NPPV (*B* and *C*). From Reference 112, with permission.

- ***Hemodynamic effects***

↓ **IntraThoracicPressure**

↓ **Preload**

↓ **Afterload**

Pulmonary congestion ⇩

⇧ **Cardiac performance**

- ***Ventilatory effects***

↑ **Alveolar recruiment** ↑ **FCR**

↑ **Alveolar ventilation** ↑ **Compliance**

↓ **Shunt**

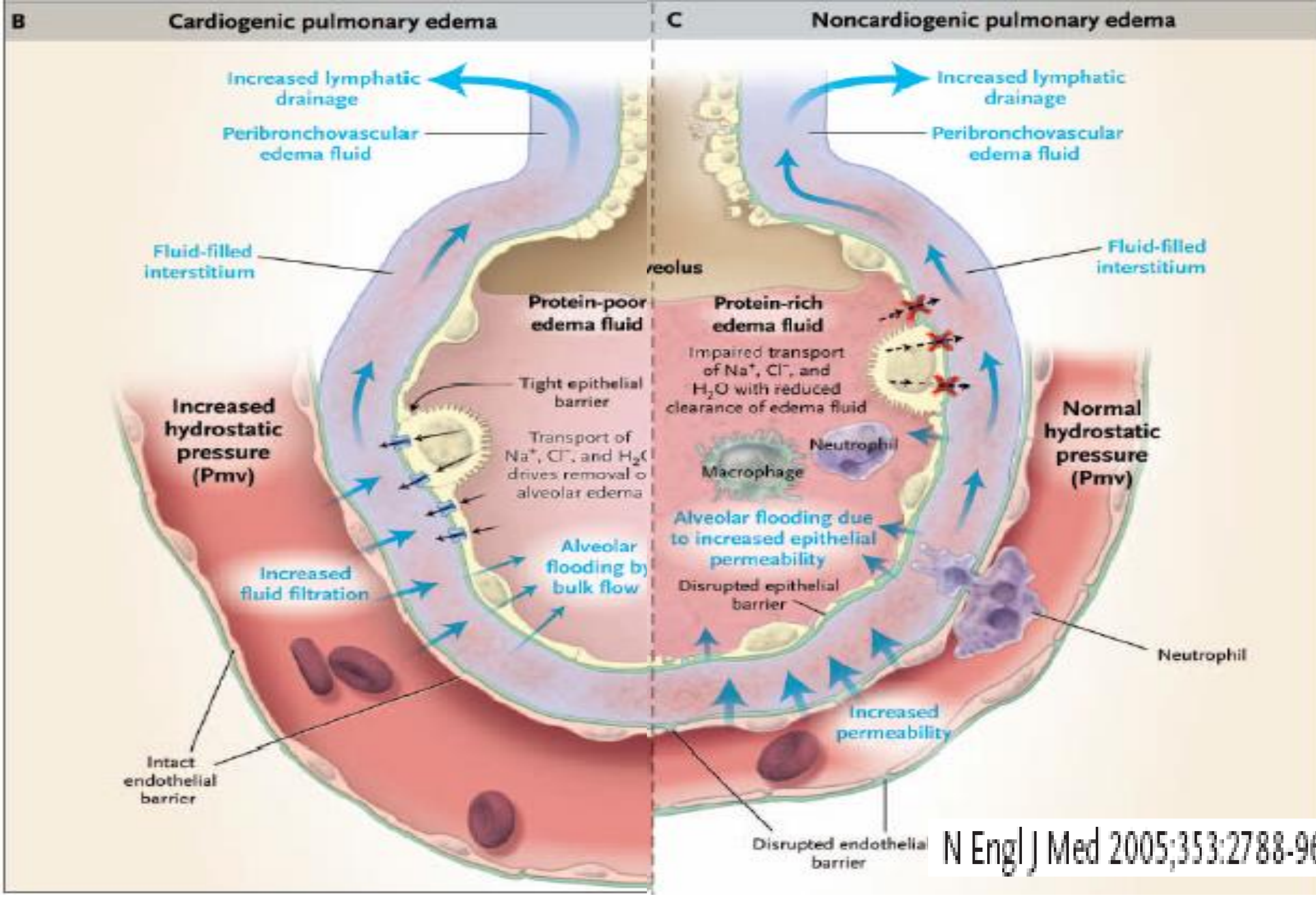
⇩ **Work of breathing**

Oxygenation ⇧

Effetti della VM a pressione positiva in corso di EPA e ARDS

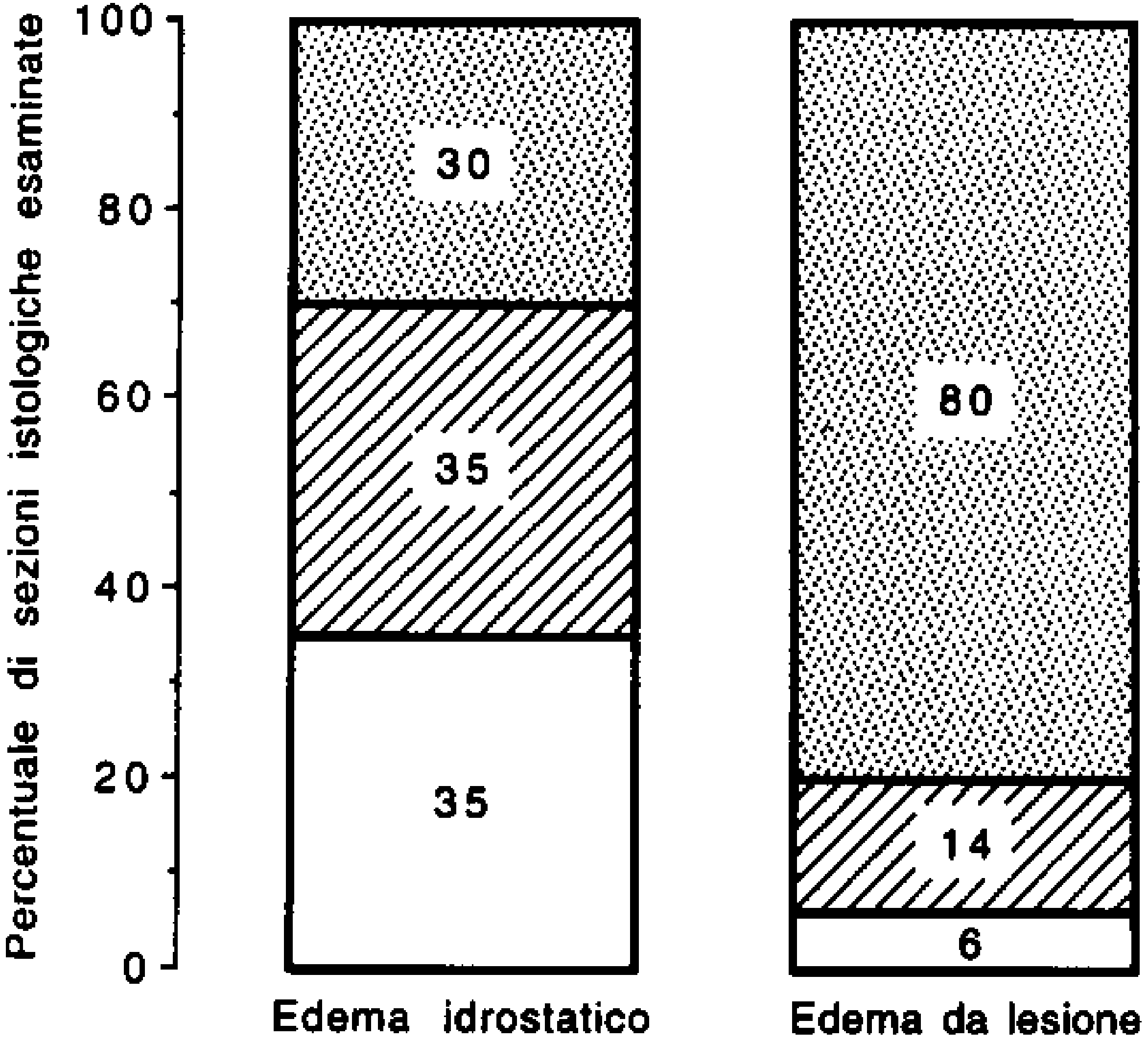
↓ Pressione transmurale →
↑ Compliance telediastolica Vsx →
↓ Post-carico ventricolare sx

PEEP → ↑ CFR → ↑ O_2 alveolare →
↓ Vasocostrizione polmonare
↓ RVP



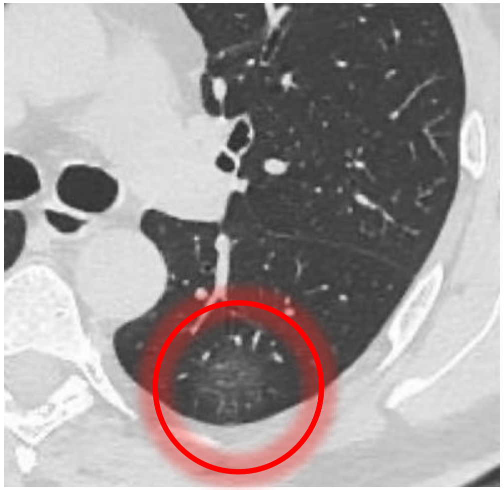
N Engl J Med 2005;353:2788-96.

$$Q° = K\,(Pc - Pi) - \sigma\,(\pi p - \pi i)$$



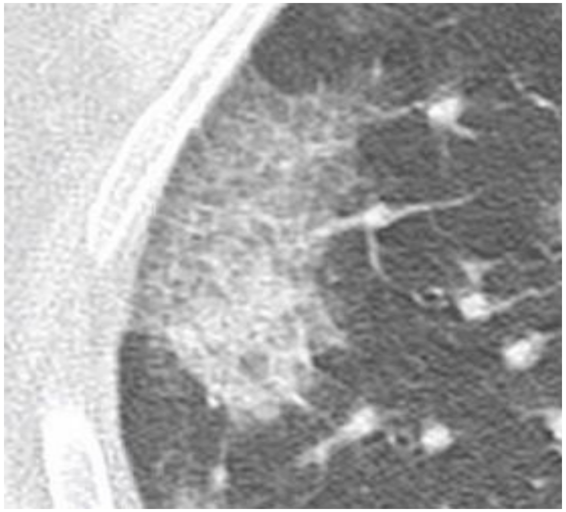
Distribuzione relativa di edema nei compartimenti interstiziale ed alveolare

Montaner et al. J Clin Invest 1986

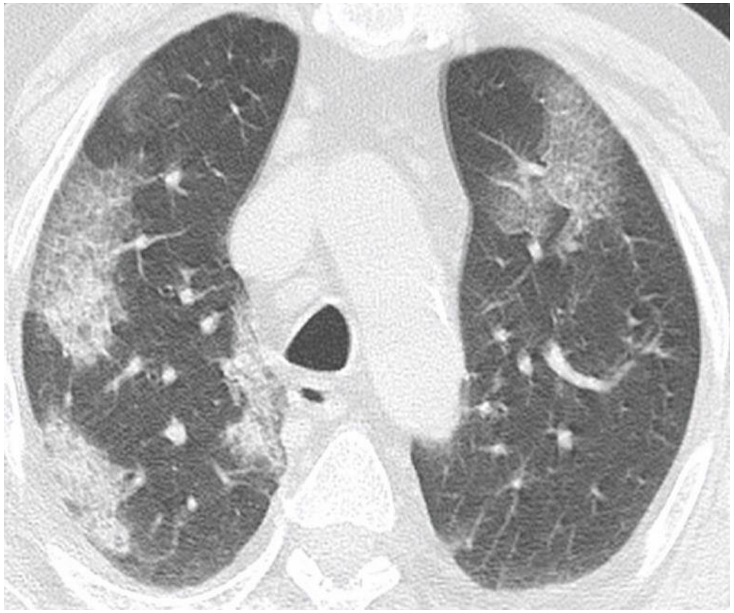


Il Danno Alveolare Diffuso (*fase acuta*, 0-4 giorni) la *lesione ground glass isolata*, anche in forma multipla e sparsa

Le opacità ground glass tendono a confluire in aree sempre più estese, conservando la prevalente distribuzione mantellare e preferenzialmente posteriore.



Progressione *acuta* → *intermedia*, compare spesso una modifica del pattern di partenza: nell'88% circa dei casi spunta il *crazy paving, per* ispessimento dei setti intra- e perilobulari *(edema infiammatorio e mediatori cellulari)*



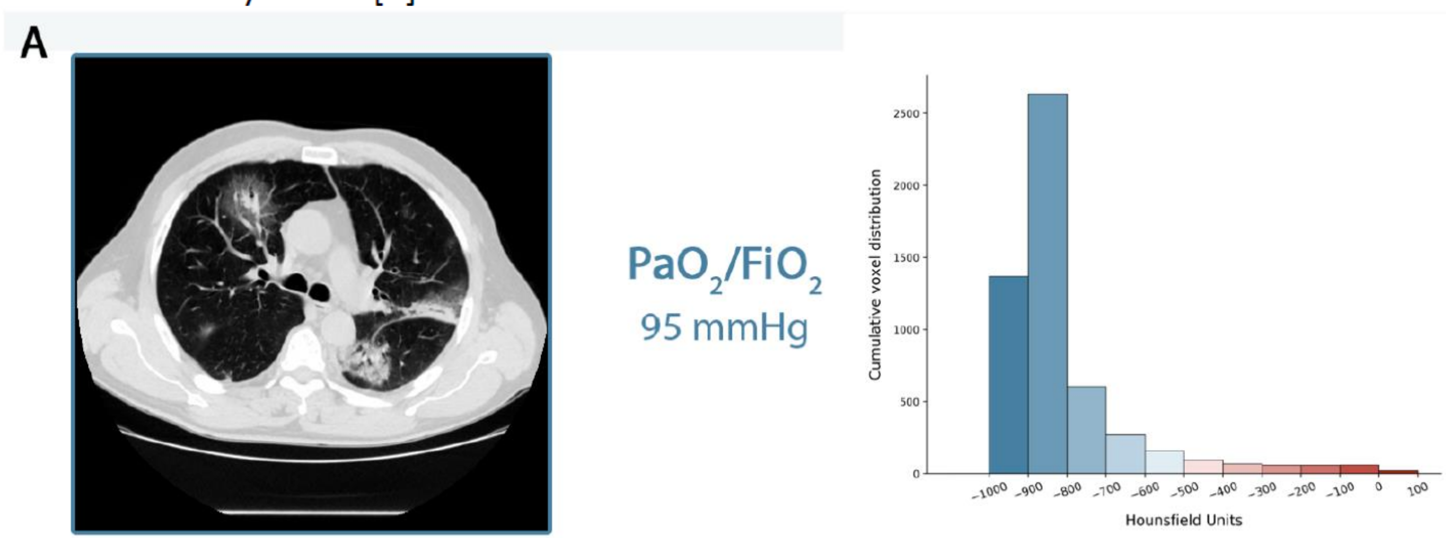
fase intermedia (organizzativo-proliferativa)
consolidazioni parenchimali: l'essudato alveolare si compatta

fase avanzata: ARDS

COVID-19 pneumonia, Type L

At the beginning, COVID-19 pneumonia presents with the following characteristics:

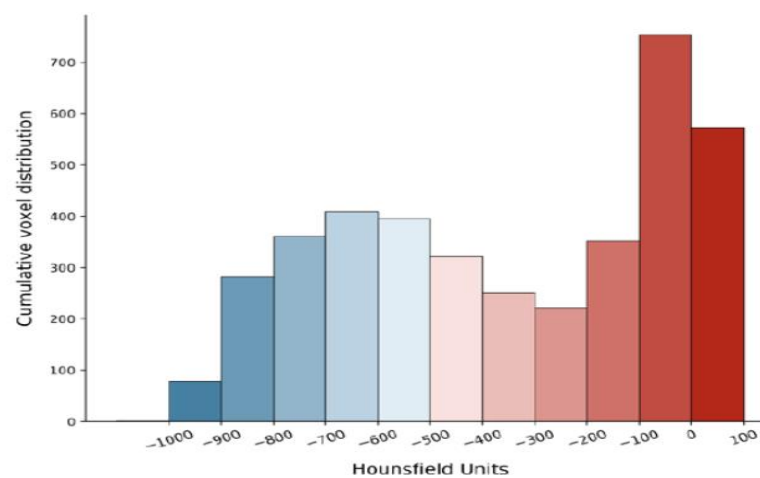
- Low elastance: the nearly normal compliance indicates that the amount of gas in the lung is nearly normal [3].
- Low ventilation to perfusion (VA/Q) ratio: since the gas volume is nearly normal, hypoxemia may be best explained by the loss of regulation of perfusion and by loss of hypoxic vasoconstriction. Accordingly, at this stage, the pulmonary artery pressure, should be near normal.
- Low lung weight: Only ground-glass densities are present on CT scan, primarily located subpleurally and along the lung fissures. Consequently, lung weight is only moderately increased.
- Low lung recruitability: the amount of non-aerated tissue is very low, consequently the recruitability is low [4].

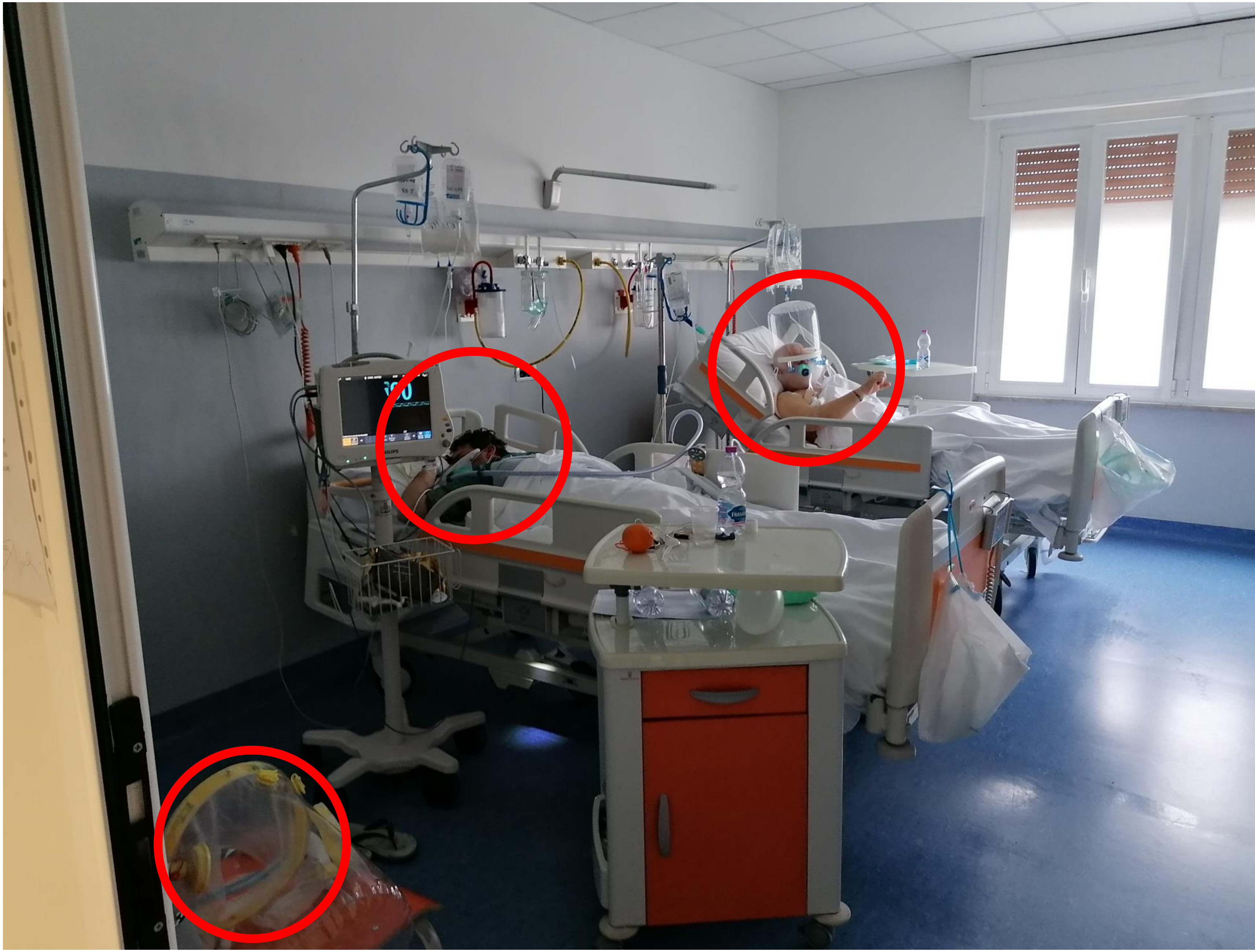


The Type H patient

- High elastance: The decrease of gas volume due to increased edema accounts for the increased lung elastance.
- High right-to-left shunt: This is due to the fraction of cardiac output perfusing the non-aerated tissue which develops in the dependent lung regions due to the increased edema and superimposed pressure.
- High lung weight: Quantitative analysis of the CT scan shows a remarkable increase in lung weight (> 1.5 kg), on the order of magnitude of severe ARDS [11].
- High lung recruitability: The increased amount of non-aerated tissue is associated, as in severe ARDS, with increased recruitability [12].

PaO_2/FiO_2
84 mmHg





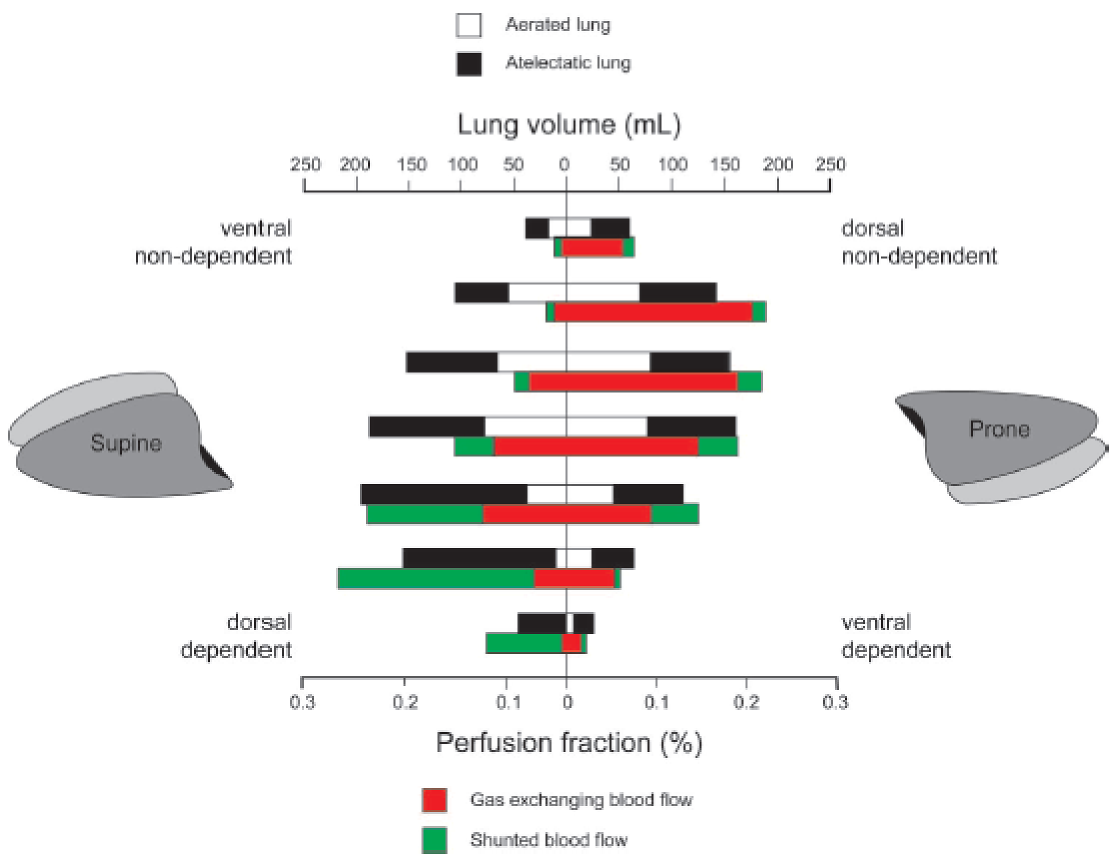


Fig. 7. Lung lavage model of ARDS in sheep that measured regional perfusion and aerated lung with PET. The lungs of each animal were partitioned into 7 isogravitational planes in both supine and prone postures. The lung volume and perfusion fraction in each plane are depicted by the length of the horizontal bars in each posture. Note the large amount of atelectactic lung and the large amount of shunted blood in the dependent lung regions in the supine compared with the prone posture. Also note that there is more blood flow in the non-dependent lung regions in the prone posture. The figure demonstrates that ventilation improves most in the dorsal lung, and blood flow remains greatest in the dorsal lung in the prone posture, thereby decreasing venous admixture and improving gas exchange. Data from Reference 97.

Table 3 The Berlin definition of ARDS (with permission from [22])

	Acute respiratory distress syndrome		
Timing	Within 1 week of a known clinical insult or new/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 (e.g., echocardiography) to exclude hydrostatic edema if no risk factor present		
	Mild	Moderate	Severe
Oxygenation[b]	$200 < PaO_2/FiO_2 \leq 300$ with PEEP or CPAP $\geq 5\ cmH_2O$[c]	$100 < PaO_2/FiO_2 \leq 200$ with PEEP $\geq 5\ cmH_2O$	$PaO_2/FiO2 \leq 100$ with PEEP $\geq 5\ cmH_2O$

ARDS acute respiratory distress syndrome, *PaO_2* partial pressure of arterial oxygen, *FiO_2* fraction of inspired oxygen, *PEEP* positive end-expiratory pressure, *CPAP* continuous positive airway pressure, *N/A* not applicable

[a] Chest X-ray or CT scan

[b] If altitude higher than 1000 m, correction factor should be made as follows: $PaO_2/FiO_2 \times$ (barometric pressure/760)

[c] This may be delivered non-invasively in the mild ARDS group

Intensive Care Med (2012) 38:1573–1582
DOI 10.1007/s00134-012-2682-1

The Berlin definition of ARDS: an expanded rationale, justification, and supplementary material

JAMA. 2012;307(23):2526-2533
Published online May 21, 2012.
doi:10.1001/jama.2012.5669

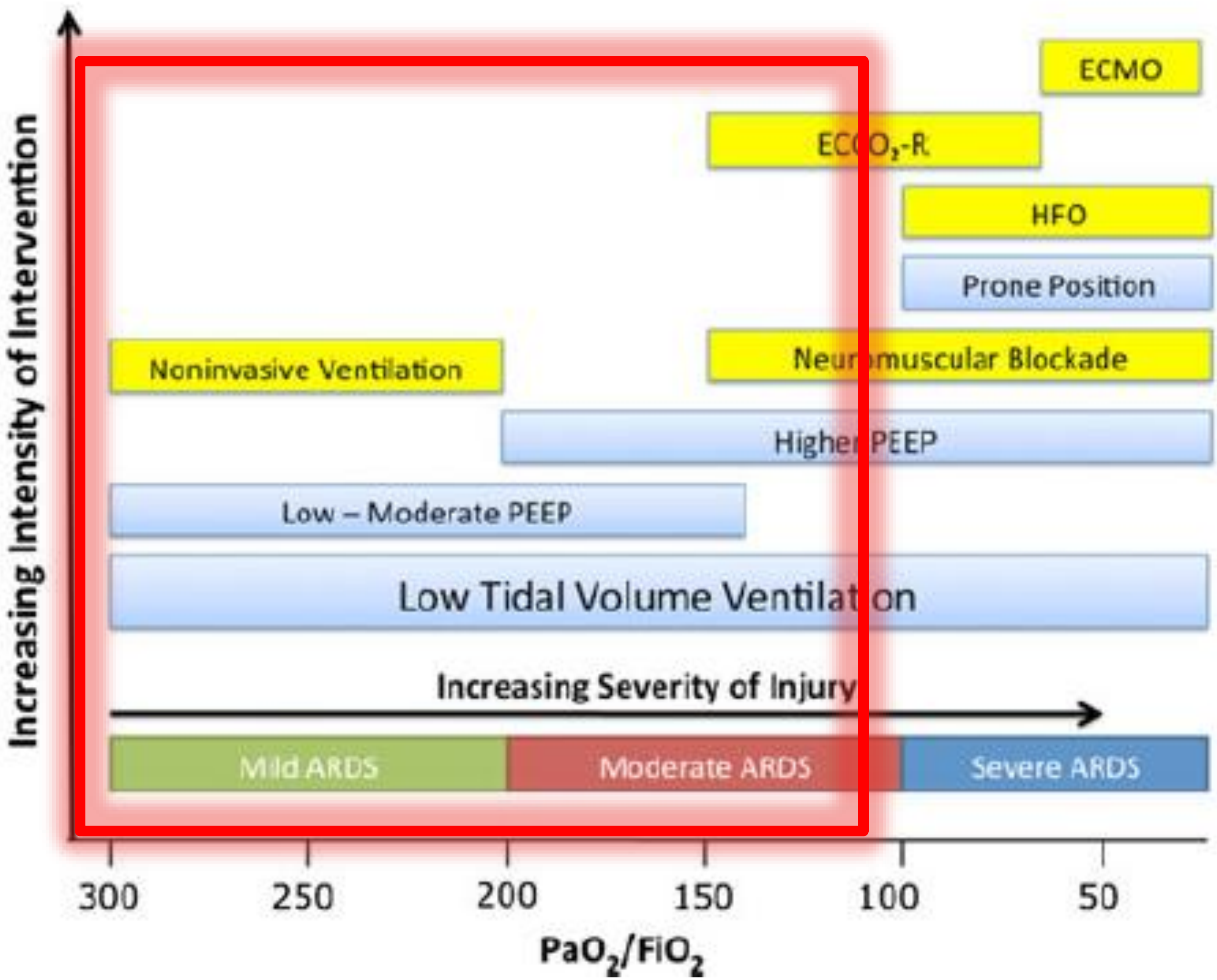

ECMO
ECCO$_2$-R
HFO
Prone Position
Noninvasive Ventilation
Neuromuscular Blockade
Higher PEEP
Low – Moderate PEEP
Low Tidal Volume Ventilation
Increasing Severity of Injury
Mild ARDS
Moderate ARDS
Severe ARDS
Increasing Intensity of Intervention
300
250
200
150
100
50
PaO$_2$/FiO$_2$

Table 5.5 *Factors influencing the success of non-invasive mechanical ventilation*

Location
Interface
Ventilator type, mode and setting
Monitoring
Indication
Motivation of the staff
Training of the staff
Experience of the staff
Size of staff
Time consumption
Organization of team