Essences From ERS Congress 2021

COBEL DAROU

In the Name of God

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Essences From
ERS Congress 2021

IR/OTH/2022/0016

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Guideline Session - High Flow Nasal Cannula in Adults with Acute Respiratory Failure

Dr. Ali Taghizadieh

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Physiologic rationale and clinical pitfalls

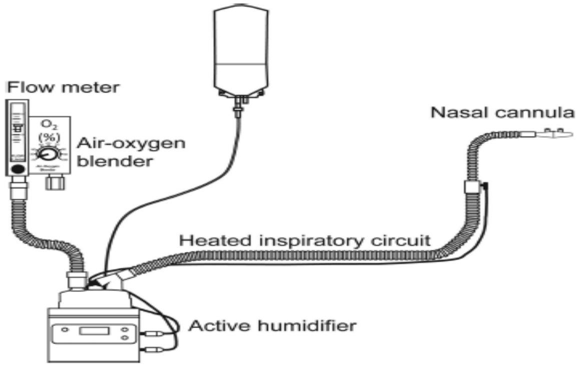
Raffaele Scala

Pulmonology and RICU

S. Donato H, Arezzo -ITALY-

Fig. 2.2 More commonly used HFNC delivery systems. From left to right: Precision Flow (Vapotherm). (From F. Javier Pilar and Yolanda M. Lopez Fernandez. High-Flow Nasal Cannula Oxygen in Acute Respiratory Post-extubation Failure in Pediatric Patients: Key Practical Topics and Clinical Implications In: Esquinas A. (eds). Noninvasive Mechanical Ventilation and Difficult Weaning in Critical Care. Springer, Cham, image used with permission); Optiflow™ system (Fisher & Paykel Healthcare); Optiflow™ Junior with AIRVO 2™ (Fisher & Paykel Healthcare, image used with permission).

Components of a high-flow nasal cannula delivery system. The air/oxygen blender and flow meter allow the delivery of a FiO_2 between 0.21 and 1.0 at a flow of up to 60 L/min. An active humidifier heats the gas which is then delivered by a heated inspiratory limb to the nasal cannula.



AS ACTIVE RESPIRATORY SUPPORT

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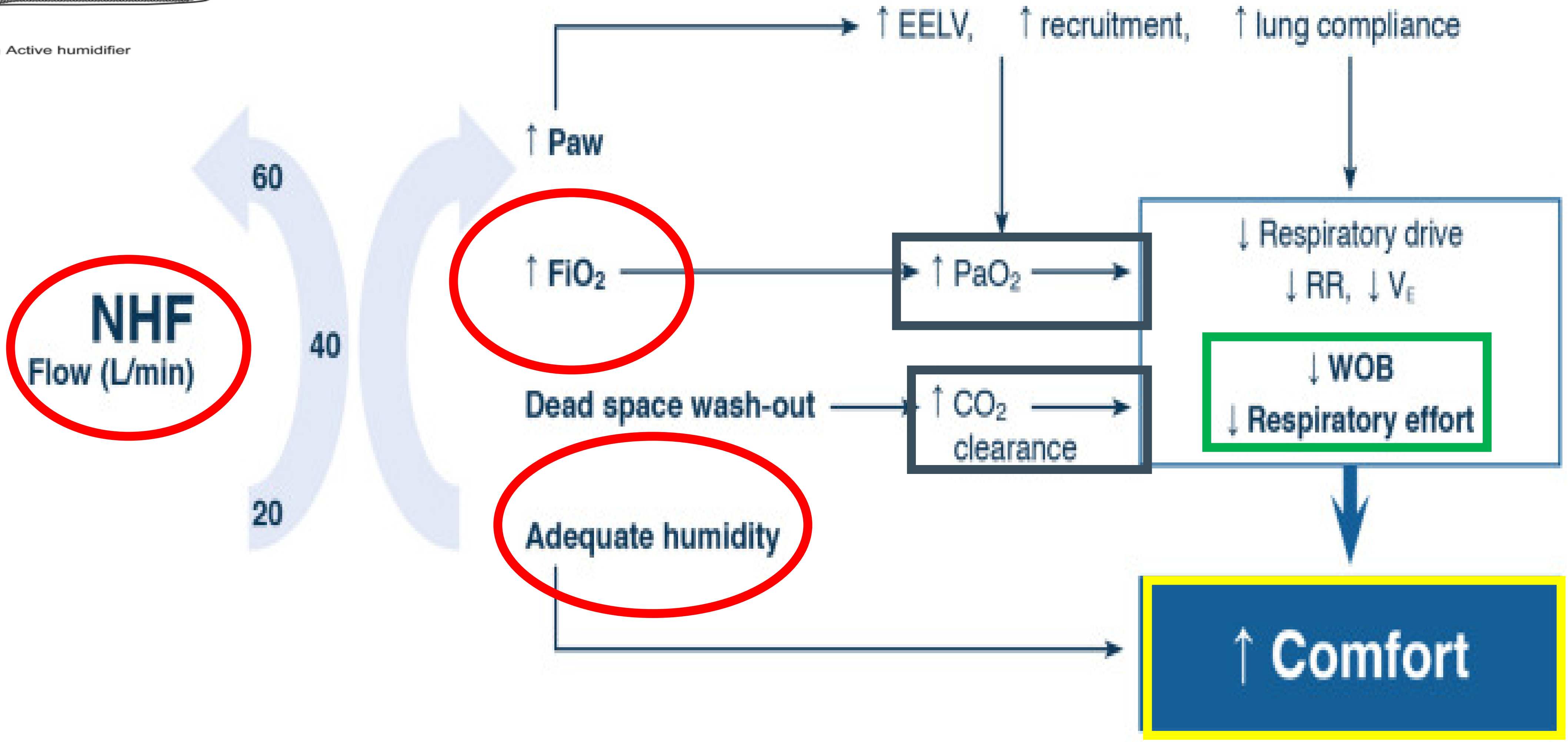
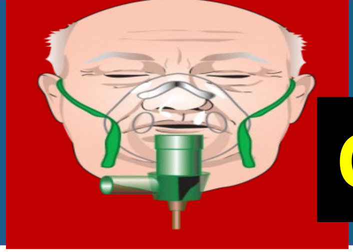
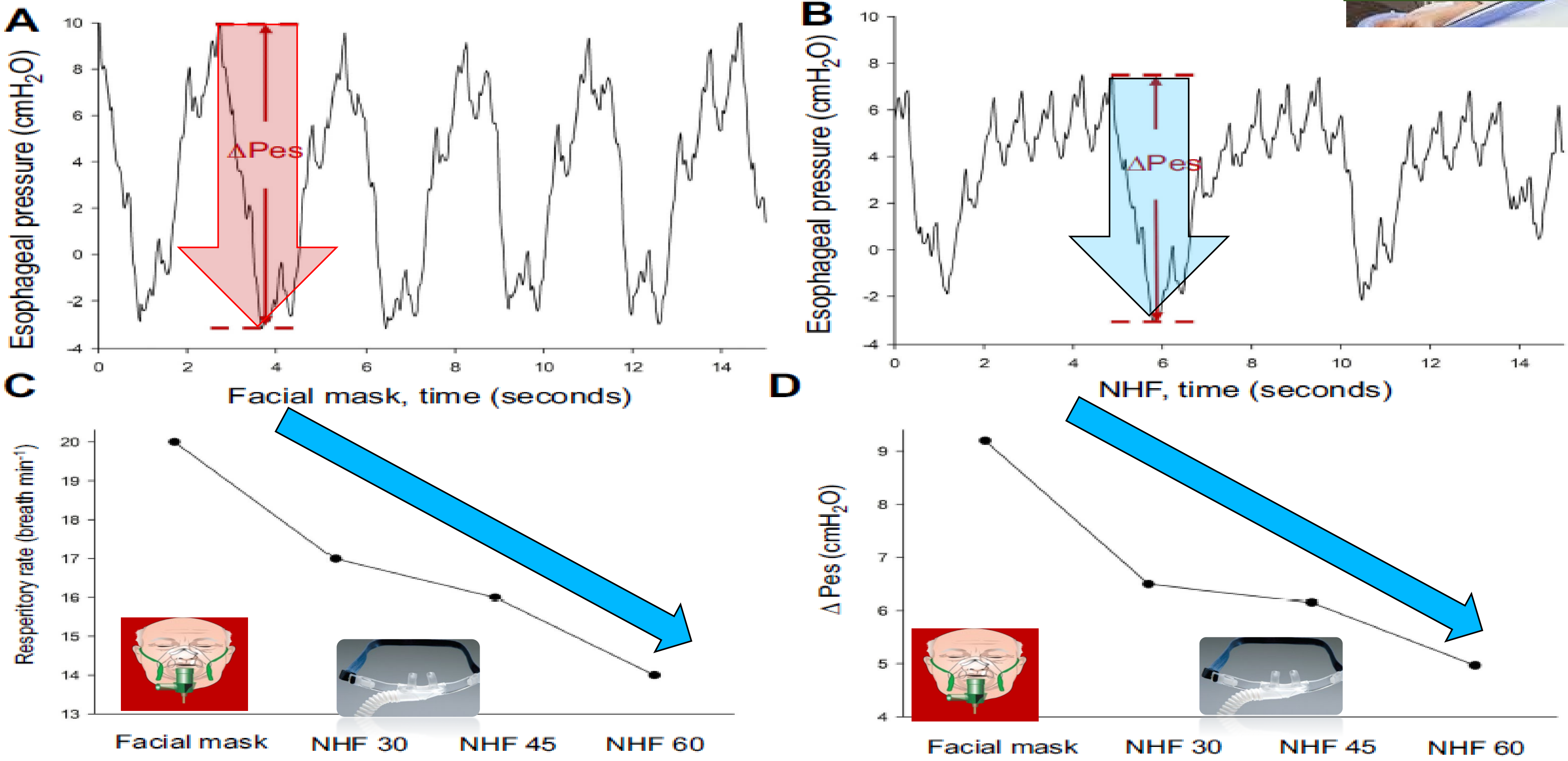




COT

FLOW-SUPPORT

HFNC



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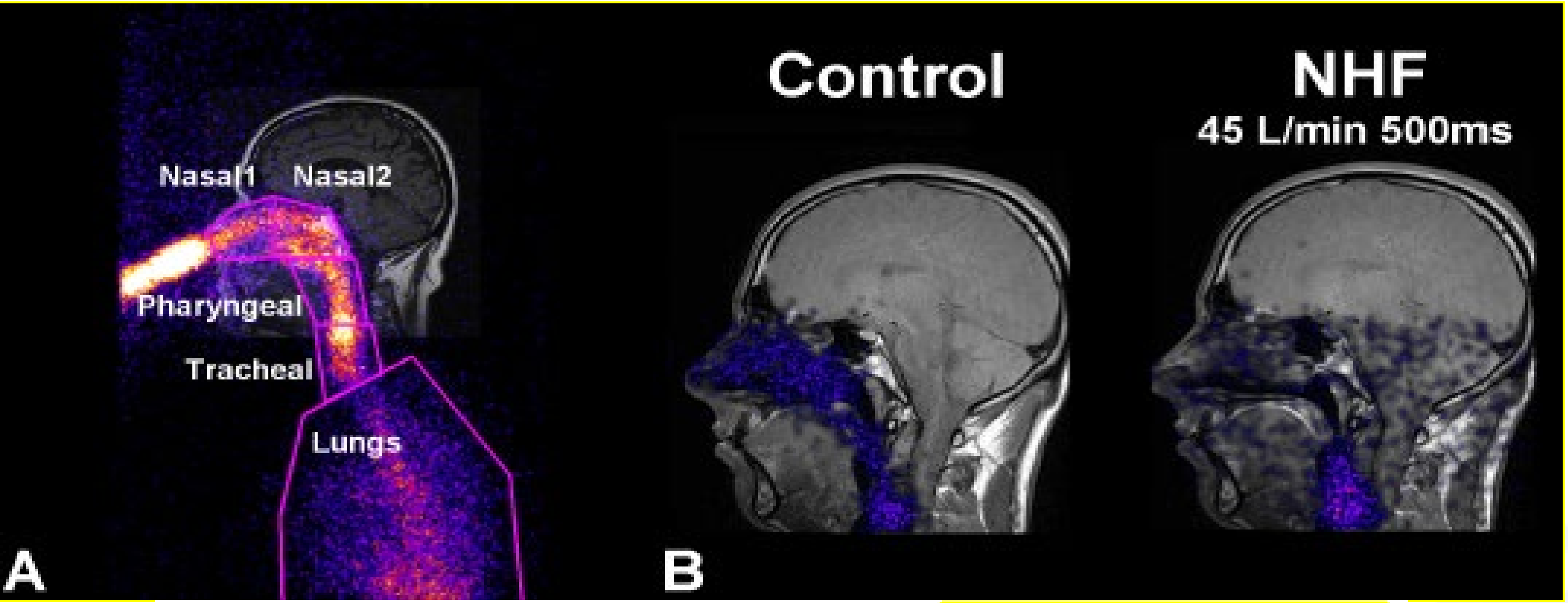
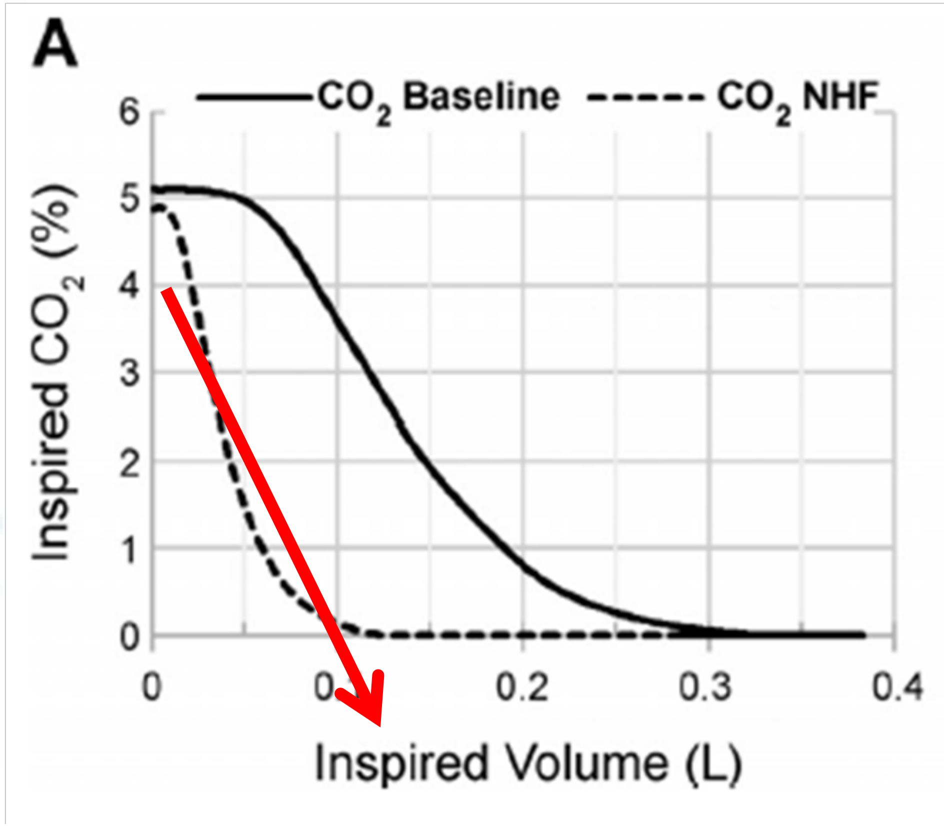
Mauri et al Open Access Emergency Medicine 2019:11 109–120

Nasal high flow reduces dead space

Winfried Möller. *J Appl Physiol* 122: 191–197, 2017.

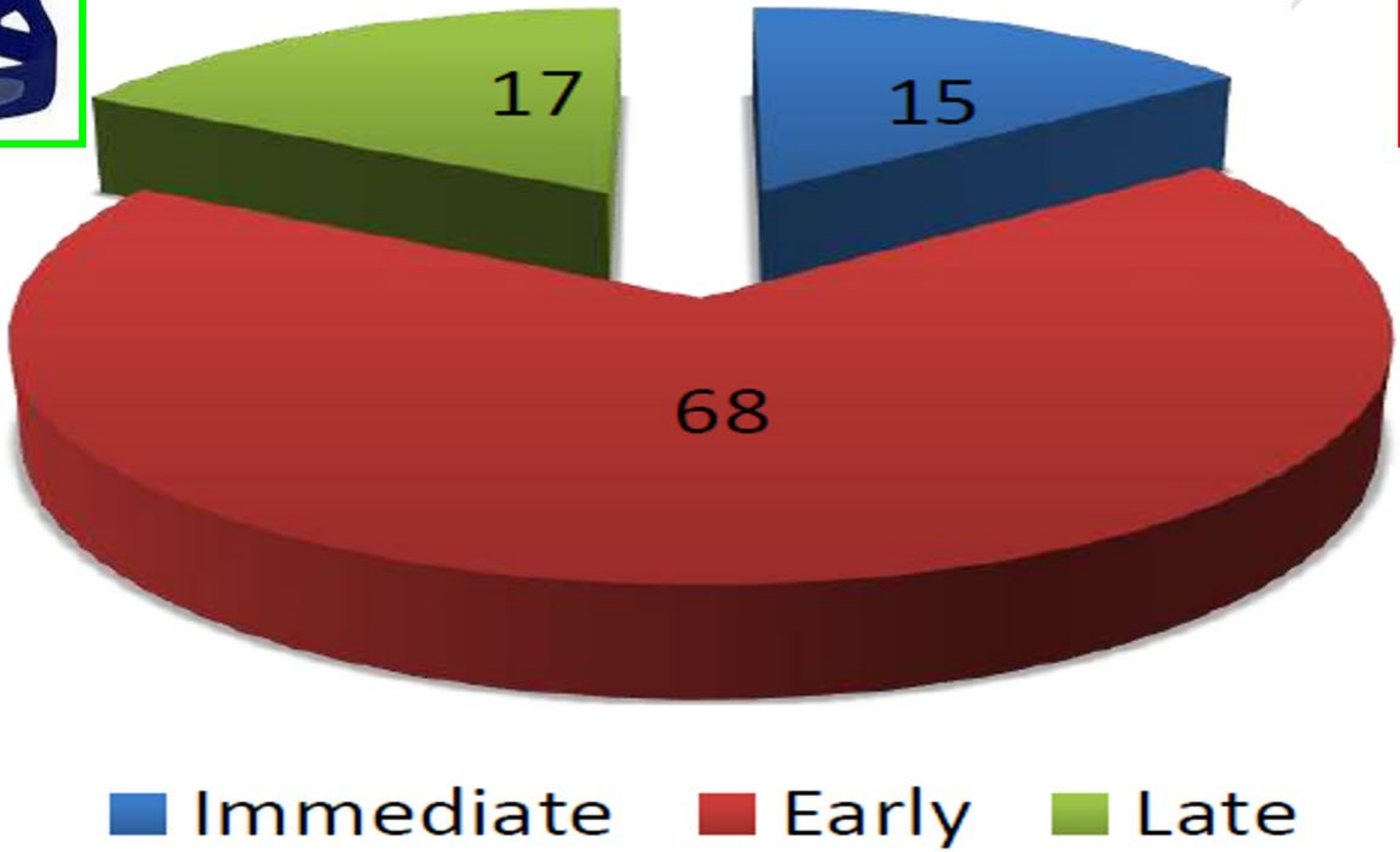


DEAD SPACE EFFECT



In summary, this study has shown effective clearance of the tracer gas by NHF in the upper airways. The clearance is directly related to the NHF rate and time, demonstrating that expired air can be cleared even below the soft palate. The clearance of dead space leads to a reduction in rebreathing of expired air. It may reduce the volume of dead space and increase the alveolar volume, which can result in improvement of alveolar ventilation and gas exchange during NHF therapy.

NIV FAILURE

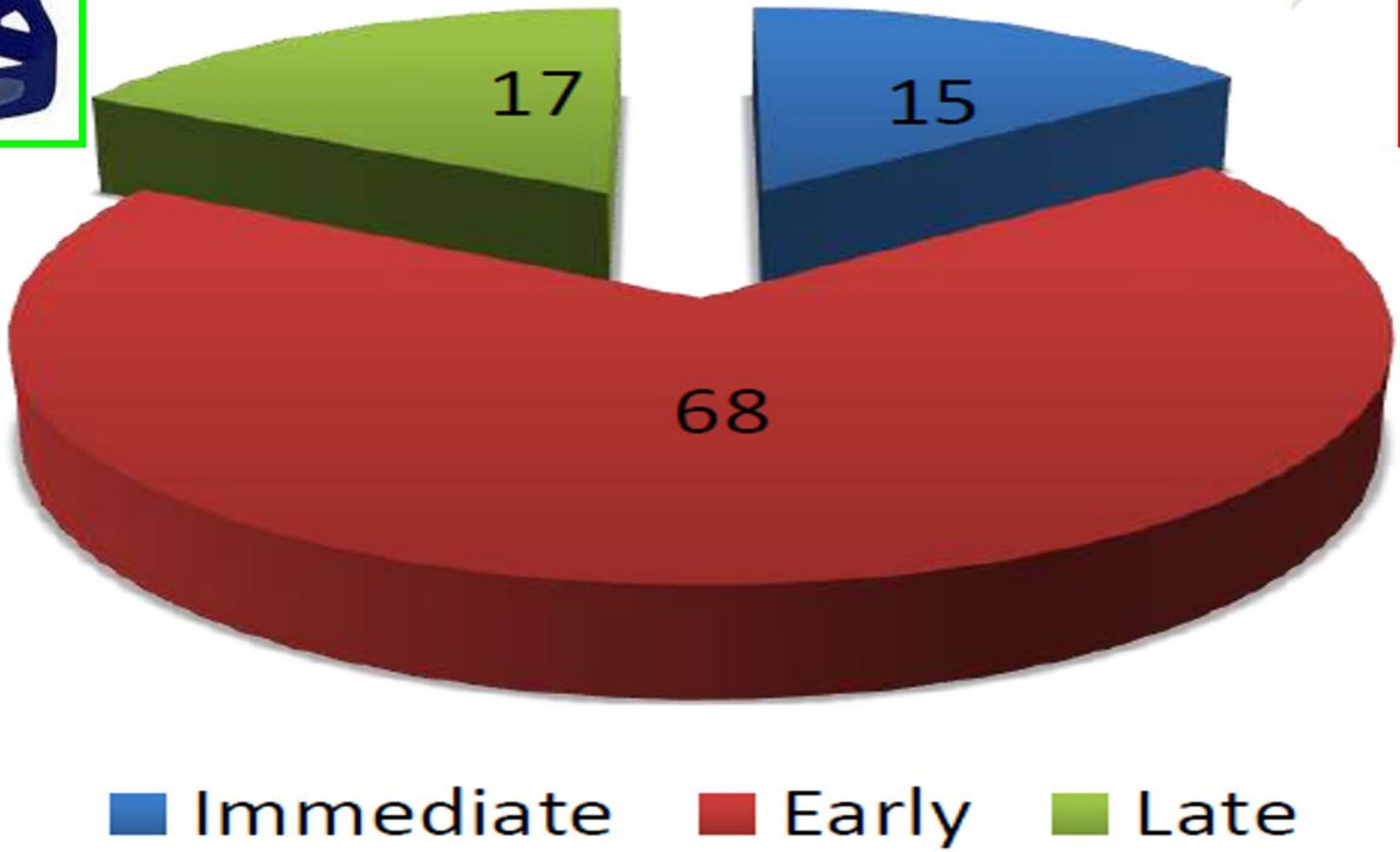


- ✧ Immediate: < 1 hr
- ✧ Early : 1- 48 hrs
- ✧ Late: > 48hrs

Ozyilmaz *et al. BMC Pulmonary Medicine* 2014, **14**:19

NIV FAILURE

NEED OF ETI: range → 5-60%



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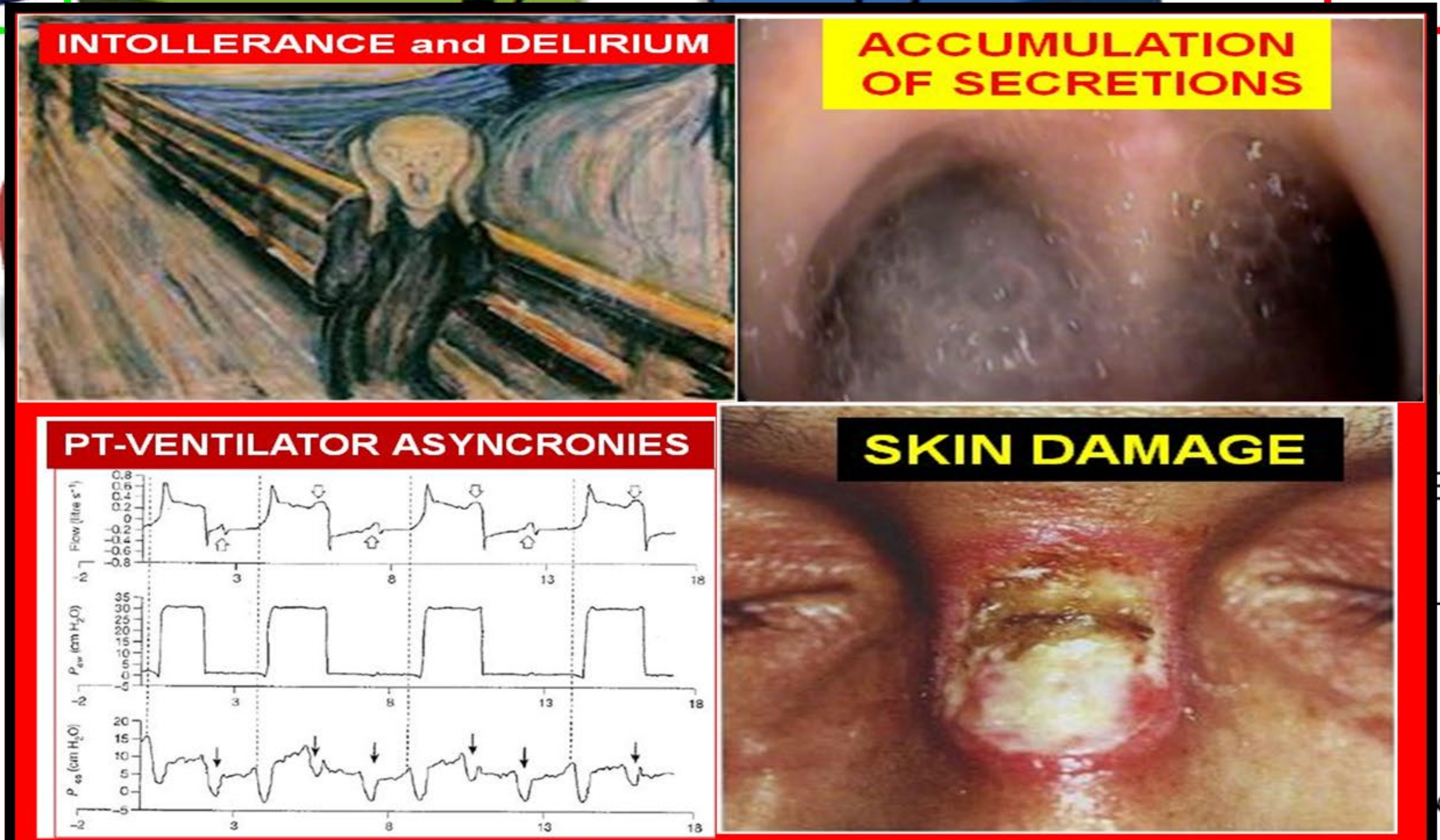

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dicine 2014, **14**:19

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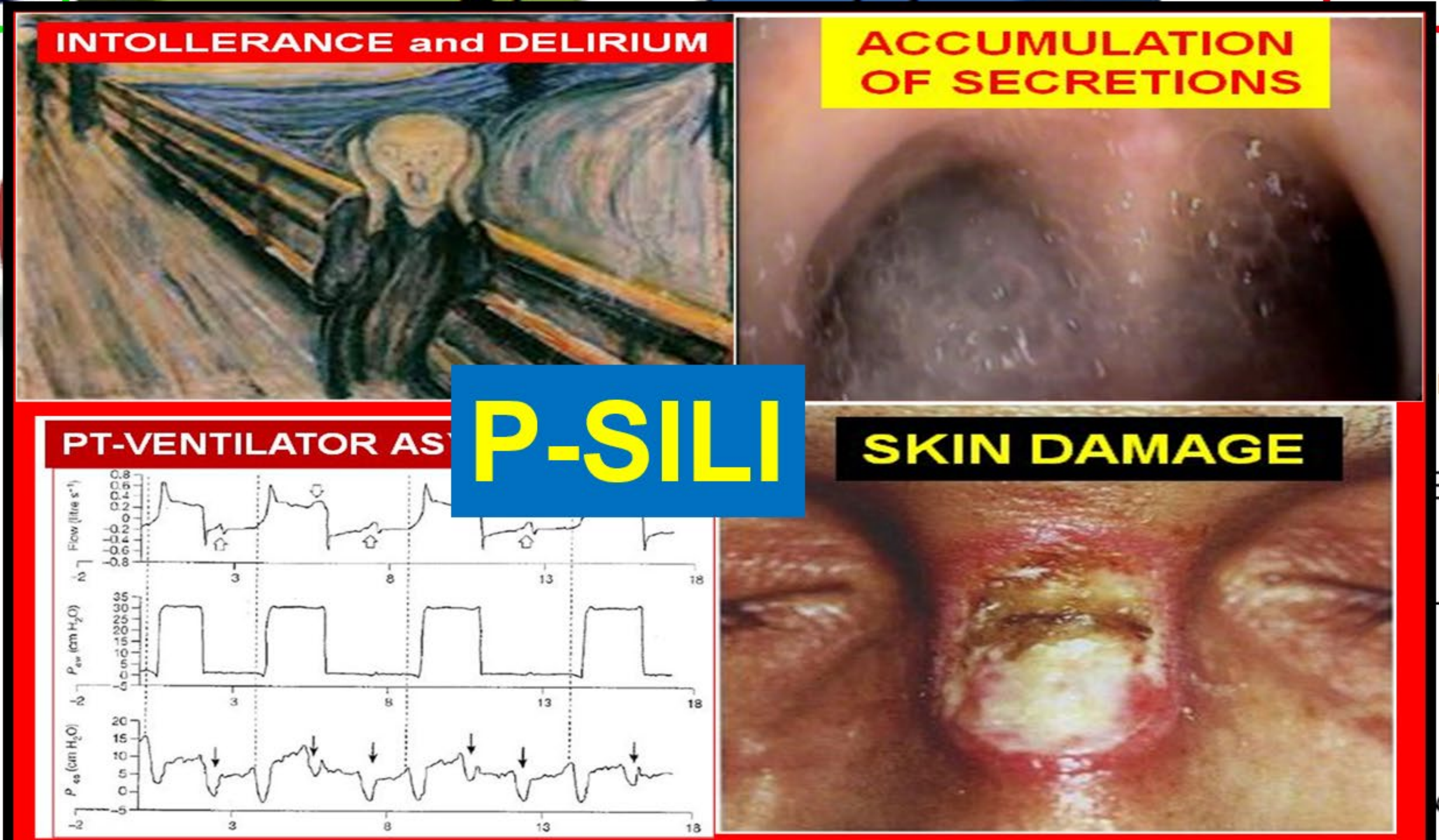

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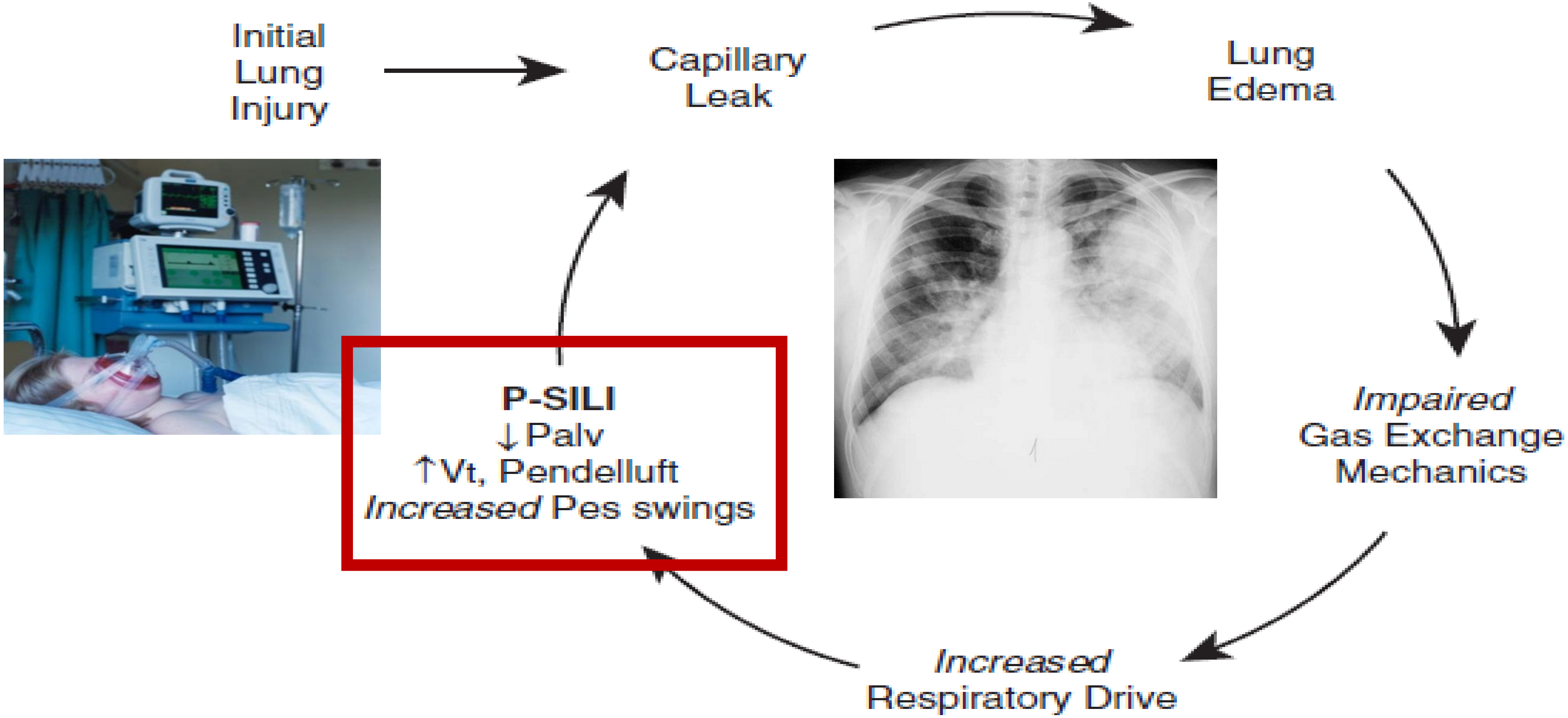
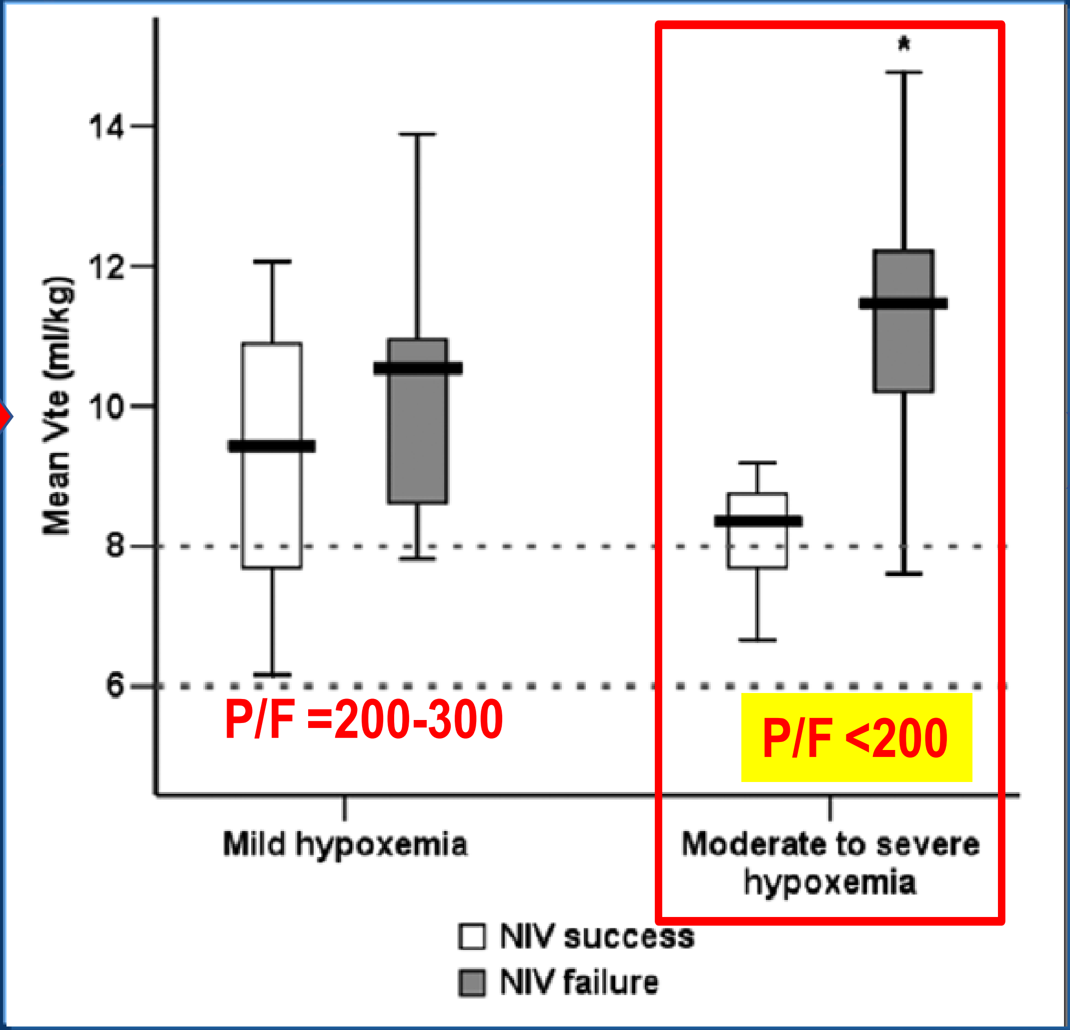
dicine 2014, **14**:19

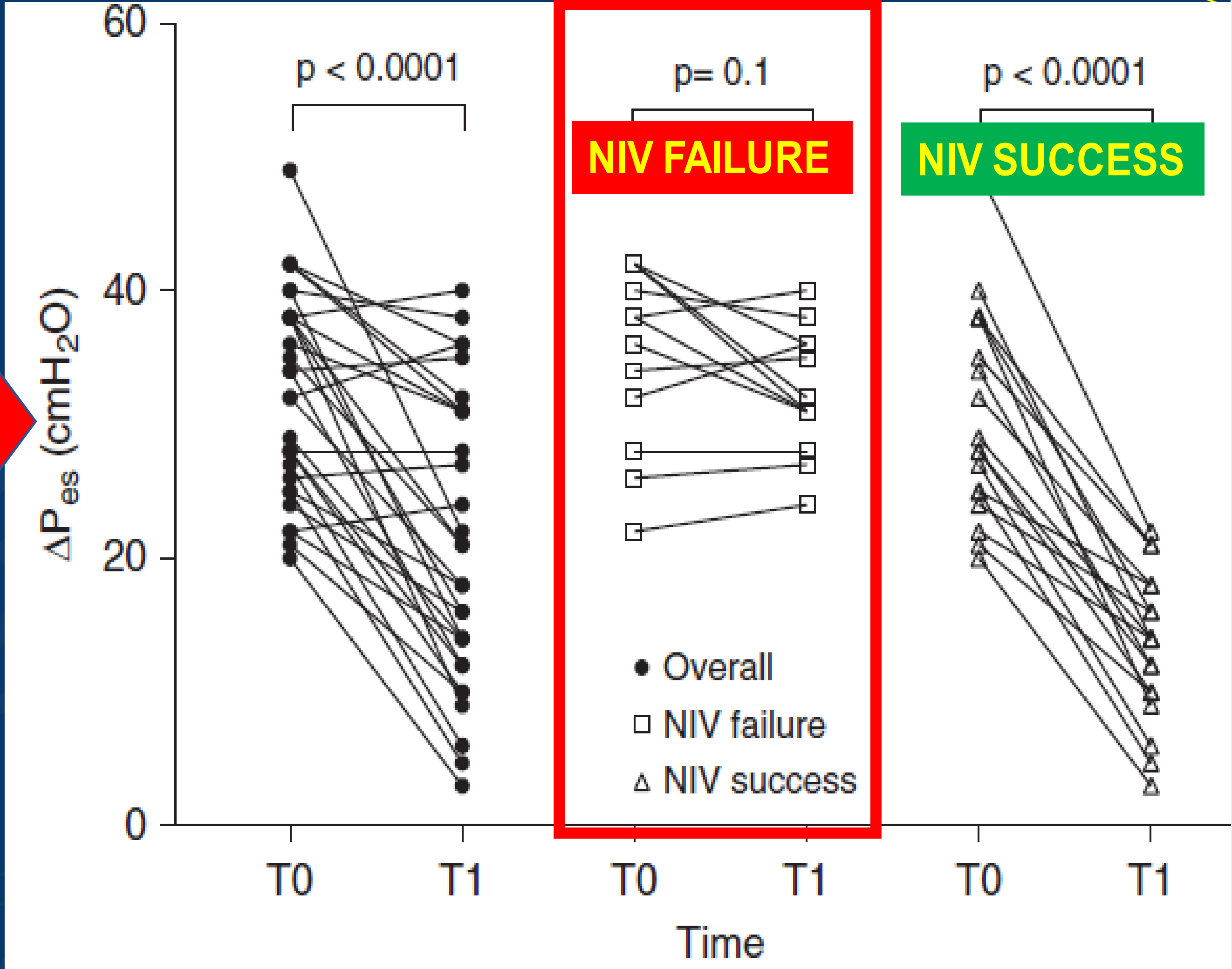
P-SILI = patient self-inflicted lung injury.



Laurent Brochard[1,2], Arthur Slutsky[1,2], and Antonio Pesenti[3,4] Am J Respir Crit Care Med Vol 195, Iss 4, pp 438–442, Feb 15, 2017

P-SILI-correlated Predictors of NIV failure

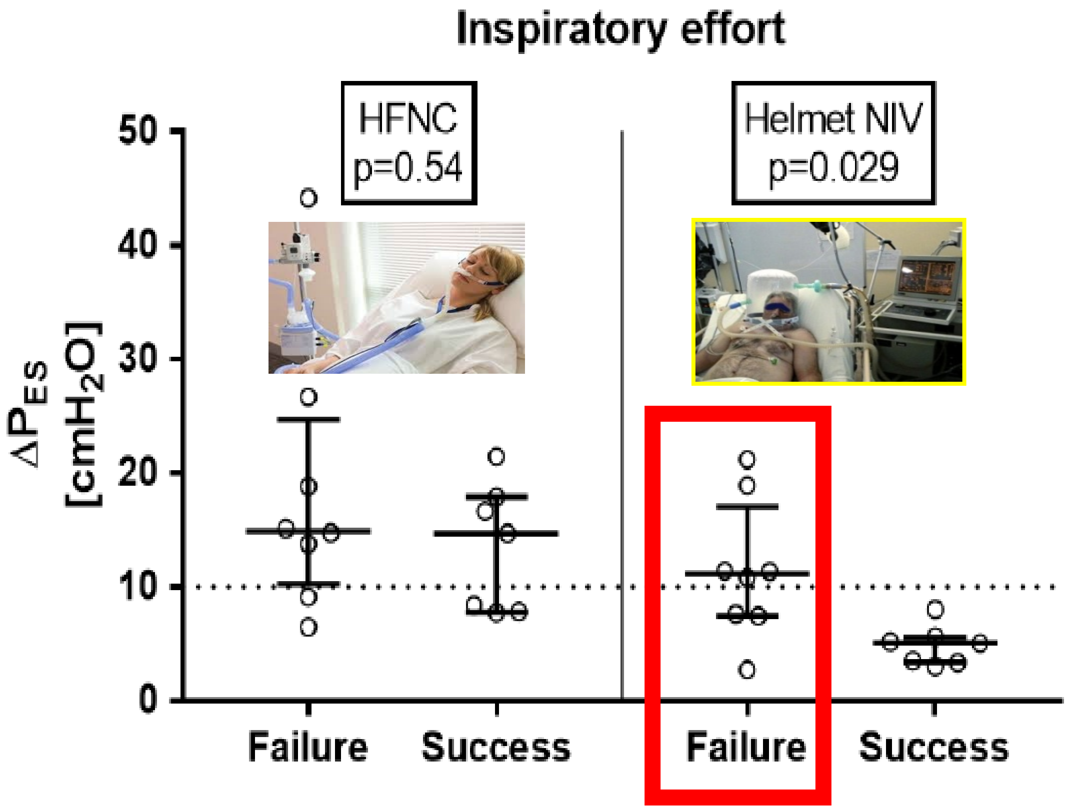


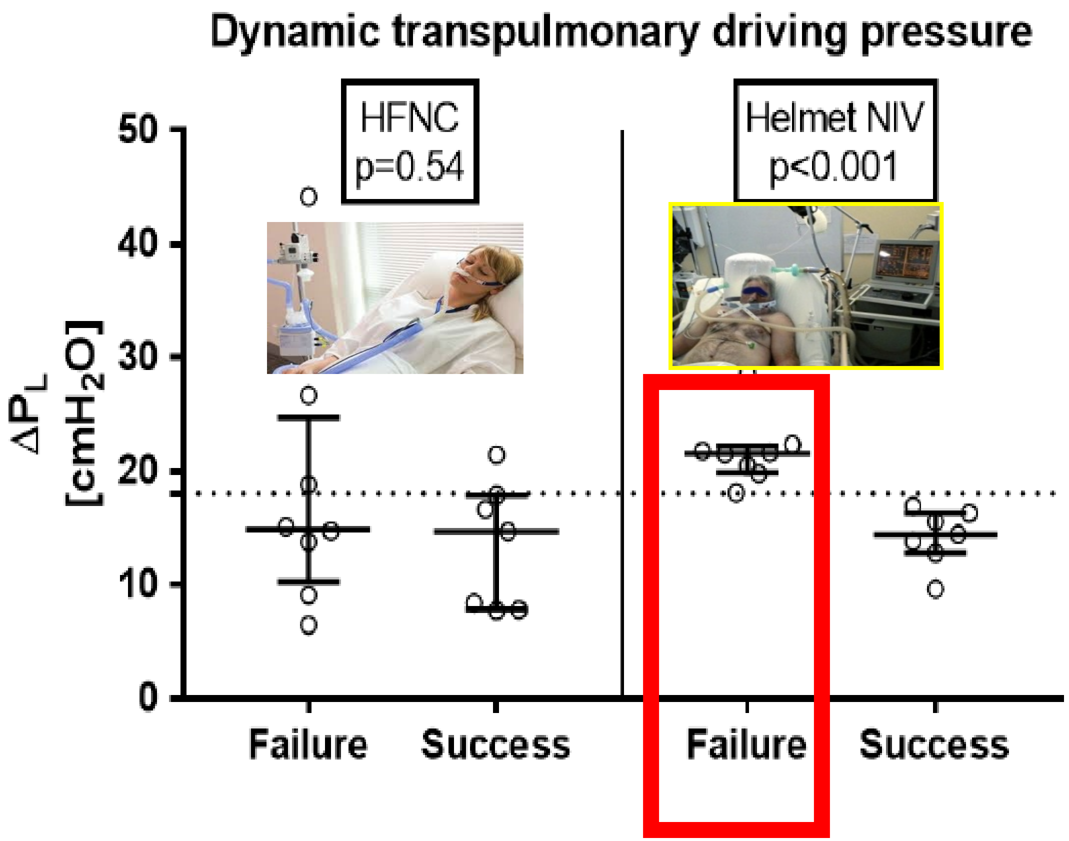


Carteaux G. et al. Crit Care Med. 2016

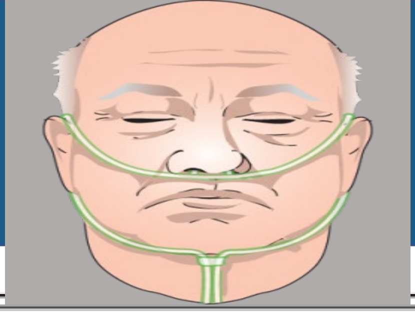
Tonelli R. et al. AJRCCM 2020

RISK OF SP-SILI IS LOWER WITH HFNC vs NIV-HELMET





Grieco DL et al. AJRCCM 2019



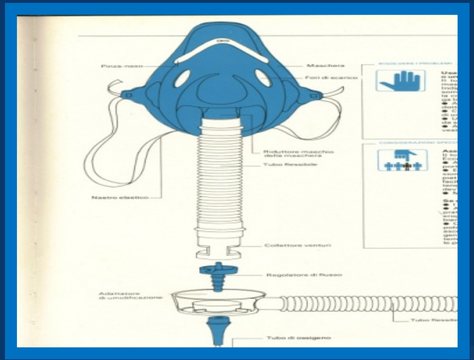
	HFNC	Conventional Oxygen Therapy	NIV
Tolerability	+++	++	+
Comfort	+++	++	+
Mucociliary function*	+++	+	+
Eating	+++	++	+
Speaking	+++	++	+
Oxygenation	++	+	+++
Ventilatory index†	++	+	+
Ventilatory efficiency	+++	+	+
Work of breathing	++	+	+++

* Preserves ventilatory function.
† Breathing frequency × P_{aCO_2}.

Nicholas S Hill

HFNC vs NIV:
Vent/pt synchrony (+++)
Risk of SILI (+/-)

NIV+HFNC: two are BETTER than one



Risk of Weaning failure may be reduced if
“NIV-free breaks” are assisted with HFNC

Failure of high-flow nasal cannula therapy may delay intubation and increase mortality

Byung Ju Kang Intensive Care Med (2015) 41:623–632

	All patients ($n = 175$)	Early HFNC failure group ($n = 130$) ETI <48 hrs	Late HFNC failure group ($n = 45$) ETI > 48 hrs	P value[a]
PaO_2/FiO_2 before HFNC, mmHg[b]	165.6 (118.0–235.7)	158.6 (112.7–222.8)	180.0 (138.4–292.0)	0.061
Primary outcome				
Overall ICU mortality, n (%)	81 (46.3)	51 (39.2)	30 (66.7)	0.001
Secondary outcomes				
Extubation success, n (%)	56 (32.0)	49 (37.7)	7 (15.6)	0.006
Ventilator-weaning, n (%)[c]	85 (48.6)	72 (55.4)	13 (28.9)	0.002
Ventilator-free days to day 28[b]	7.3 ± 9.7	8.6 ± 10.1	3.6 ± 7.5	0.001

Conclusions: Failure of HFNC might cause delayed intubation and worse clinical outcomes in patients with respiratory failure. Large prospective and randomized controlled studies on HFNC failure are needed to draw a definitive conclusion.

Failure of high-flow nasal cannula therapy may delay intubation and increase mortality

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EXTENSION OF HFNC TO NON–ICU SETTINGS

Conclusions: Failure of HFNC might cause delayed intubation and worse clinical outcomes in patients with respiratory failure. Large prospective and randomized controlled studies on HFNC failure are needed to draw a definitive conclusion.

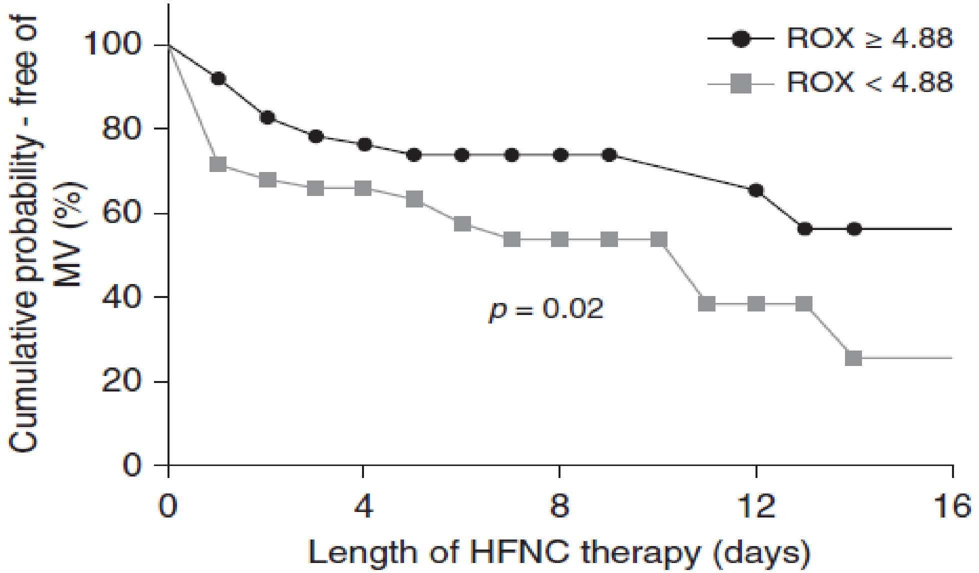
An Index Combining Respiratory Rate and Oxygenation to Predict Outcome of Nasal High-Flow Therapy

Oriol Roca[1,2], Berta Caralt[1,3], Jonathan Messika[4,5,6], Manuel Samper[7], Benjamin Sztrymf[8,9], Gonzalo Hernández[10], Marina García-de-Acilu[1], Jean-Pierre Frat[11,12,13], Joan R. Masclans[2,3,7], and Jean-Damien Ricard[4,5,6]

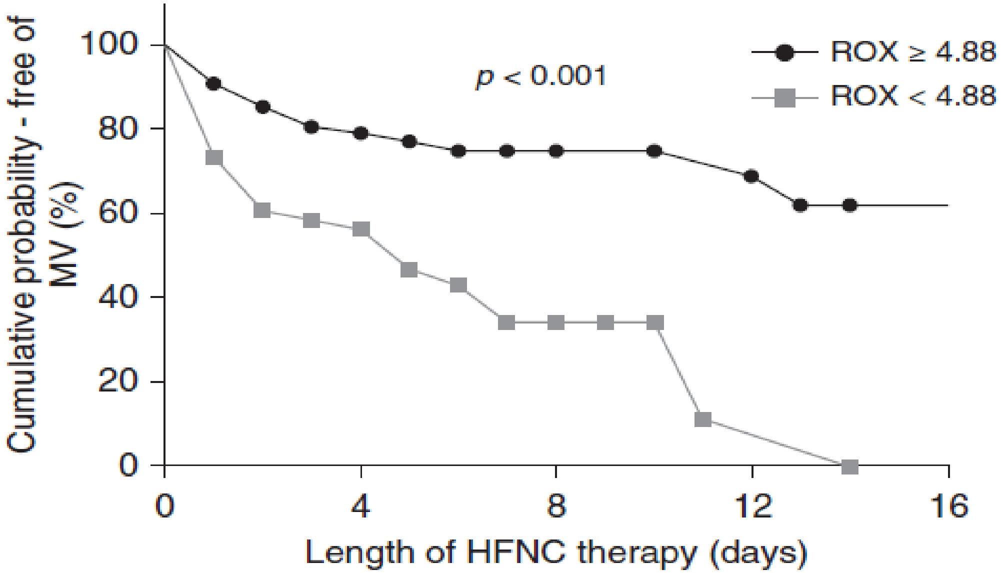
Am J Respir Crit Care Med Vol 199, Iss 11, pp 1368–1376, Jun 1, 2019

ROX INDEX= SpO2/FiO2/RR

Survival proportions according to ROX index at 2h of HFNC



Survival proportions according to ROX index at 6h of HFNC



Conclusions: In patients with pneumonia with acute respiratory failure treated with HFNC, ROX is an index that can help identify those patients with low and those with high risk for intubation.

Which flow Rate?

Table 2.1 Flow rates routinely prescribed for high-flow therapy. Source: Children's Health Queensland Hospital and Health Service. Guideline: nasal high flow therapy—management of the paediatric patient receiving high flow therapy. 2019. Queensland Government Department of Health, Brisbane

Weight	Flow rates
Neonates	Up to 8 L/min
0–12 kg	2 L/kg/min up to maximum of 25 L/min
13–15 kg	2 L/kg/min up to maximum of 30 L/min
16–30 kg	35–40 L/min
31–50 kg	40–50 L/min
>50 kg (adults)	40–70 L/min

Contraindications

Contraindications to HFNC use	Conditions which warrant careful HFNC use
Unable to protect airway Life-threatening hypoxia Base-of-skull fracture Maxillofacial trauma Recent upper airway surgery Nasal obstruction, e.g. tumour, polyps, septal deformity/trauma Severe oropharyngeal mucositis Foreign-body aspiration Epistaxis	Severe agitation, unable to follow commands Respiratory acidosis Swallowing impairment Recent neurosurgery or upper gastrointestinal surgery Poor skin integrity of face, e.g. burns
Specific additional contraindications to HFNC use in infants and children	**Specific additional conditions which warrant careful HFNC use in infants and children**
Choanal atresia Certain craniofacial malformations Severe central apnoea Trans-oesophageal fistula pre- and post-op	Bulbar dysfunction Neuromuscular hypotonia

Management Algorithm for HFNC

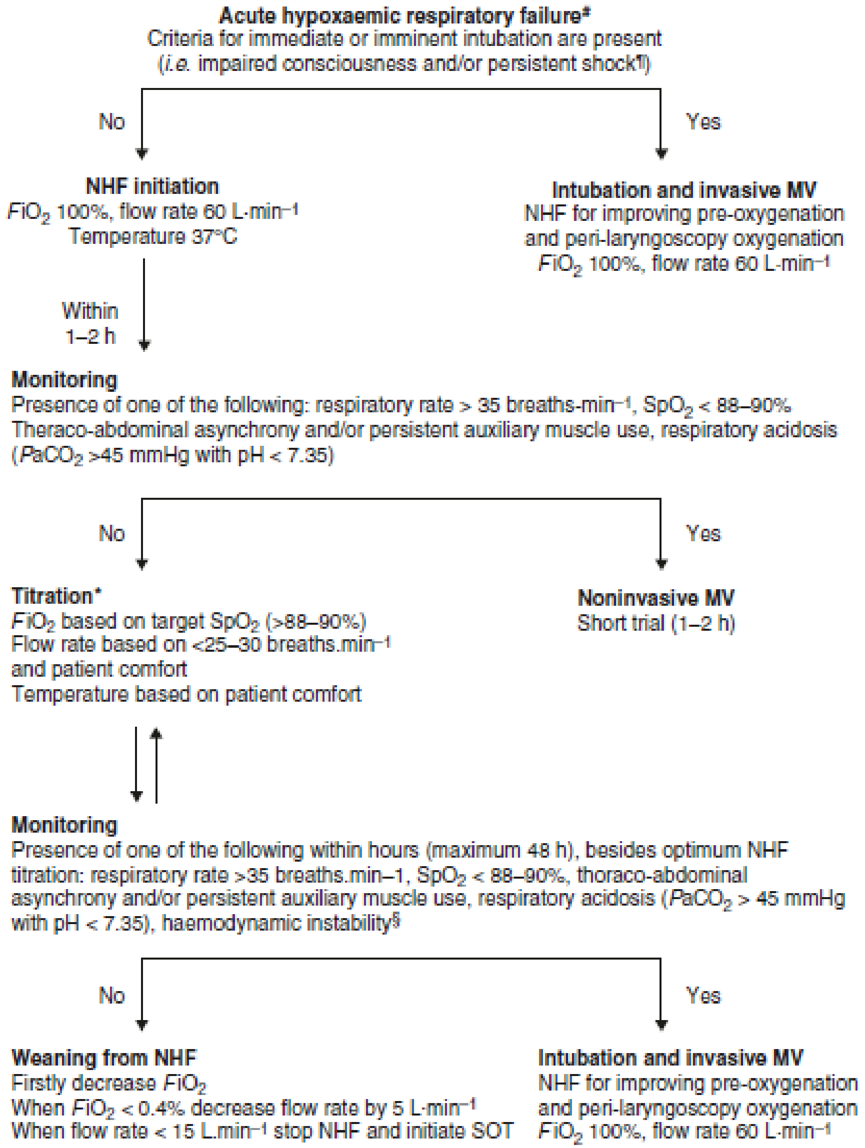
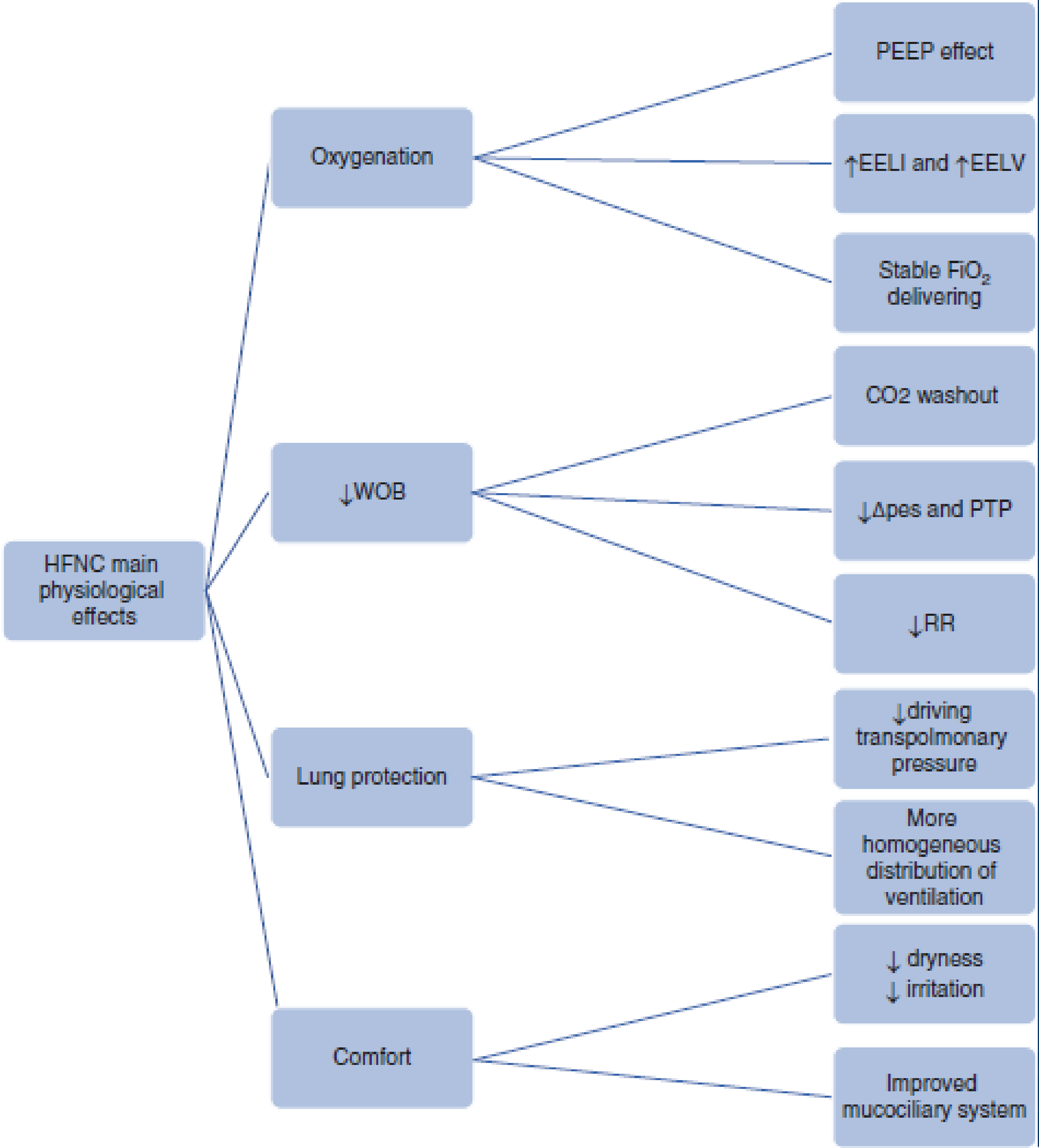


Fig. 2.3 Suggested management algorithm for adult patients in acute hypoxaemic respiratory failure. #Arterial oxygen tension (PaO2)/fraction of inspired oxygen (FiO2) ratio < 300; patients with arterial carbon dioxide tension (PaCO2) > 45 mmHg and pH <7.35 are excluded. ¶Systolic arterial blood pressure < 90 mmHg with adequate fluid administration; §haemodynamic instability is defined as a heart rate > 140 beats/min or a change of >20% from baseline and/or a systolic arterial blood pressure of >180 mmHg, <90 mmHg or a decrease of >40 mmHg from baseline; NHF, nasal high-flow oxygen therapy; MV, mechanical ventilation; SOT, standard oxygen therapy. (Reproduced with permission of the © ERS 2019: European Respiratory Review 26 (145) 170028; DOI: https://doi.org/10.1183/16000617.0028-2017 Published 9 August 2017)

Main physiological effects of HFNC therapy



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Ventilatory Limitation?

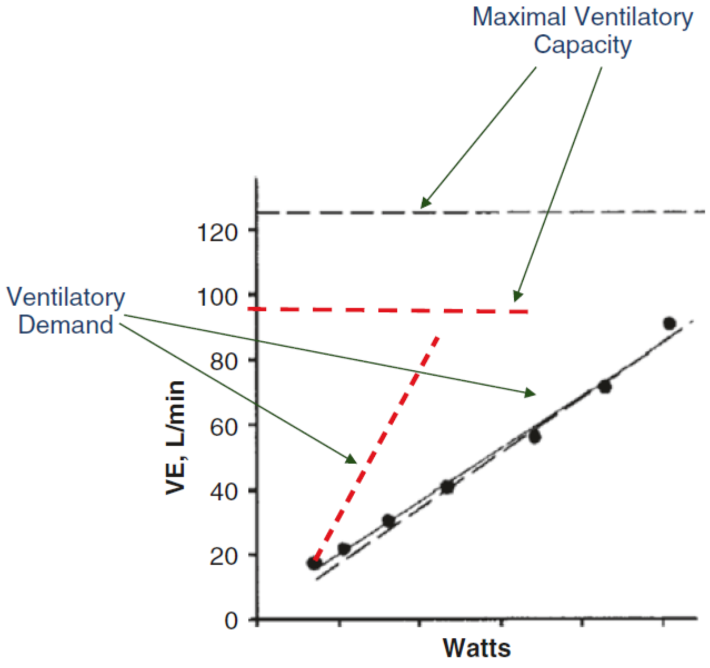

Fig. 8.2 Relation between the variation of minute ventilation (V_E) and workload in COPD (dotted red line) and normal patients (dotted black line)

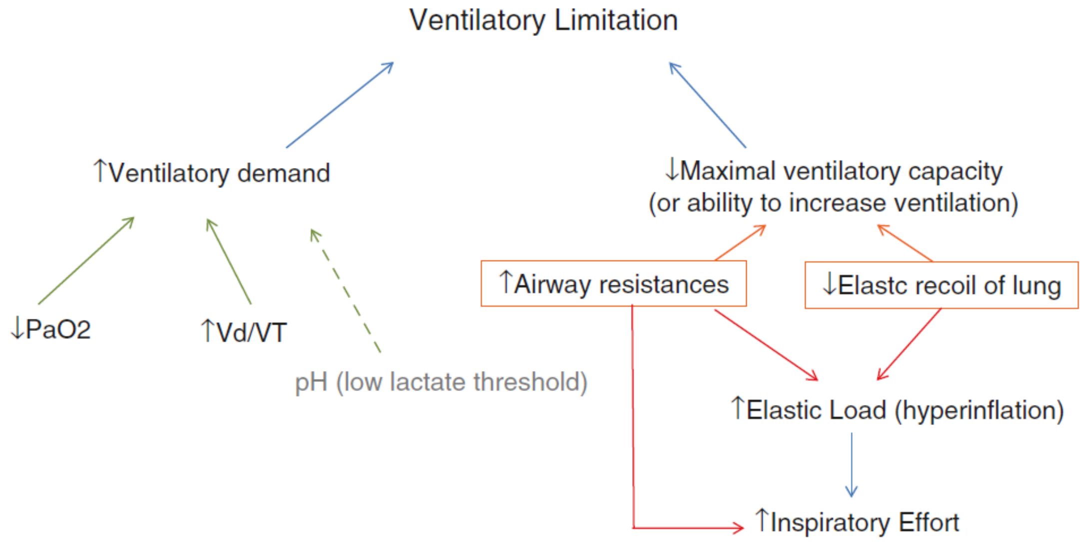

Fig. 8.1 Pathophysiological mechanisms responsible for ventilatory limitation. *Vd* dead-space volume, *VT* tidal volume

HFNC Guideline Session: Non-invasive respiratory treatment options and recommendations

Simon Oczkowski MD MHSc
Associate Professor
Departments of Medicine and Health Research Methods, Evidence, and Impact
McMaster University, Canada

Aims / Learning objectives

1. Understand meaning of recommendations in GRADE
2. Review ERS recommendations for use of HFNC in acute respiratory failure
3. Understand rationale for the ERS recommendations for use of HFNC

EUROPEAN RESPIRATORY JOURNAL
ERS OFFICIAL DOCUMENTS
S. OCZKOWSKI ET AL.

ERS clinical practice guidelines: high-flow nasal cannula in acute respiratory failure

Simon Oczkowski[1,2,26], Begüm Ergan[3,26], Lieuwe Bos[4,5], Michelle Chatwin[6], Miguel Ferrer[7], Cesare Gregoretti[8,9], Leo Heunks[10], Jean-Pierre Frat[11,12], Federico Longhini[13], Stefano Nava[14,15], Paolo Navalesi[16,17], Aylin Ozsancak Uğurlu[18], Lara Pisani[14,15], Teresa Renda[19], Arnaud W. Thille[11,12], João Carlos Winck[20], Wolfram Windisch[21], Thomy Tonia[22], Jeanette Boyd[23], Giovanni Sotgiu[24] and Raffaele Scala[25]

Cite this article as: Oczkowski S, Ergan B, Bos L, *et al*. ERS clinical practice guidelines: high-flow nasal cannula in acute respiratory failure. *Eur Respir J* 2022; 59: 2101574 [DOI: 10.1183/13993003.01574-2021].

Introduction

- High-flow nasal cannula (HFNC) is a respiratory support device, which is used during early noninvasive management of acute respiratory failure (ARF).

- The benefits of HFNC, which are both

  clinical (e.g. patient comfort and ease of use) and

  physiological (high oxygenation, alveolar recruitment, humidification and

  heating, increased secretion clearance, reduction of dead space)

- It can prevent deterioration of lung function and endotracheal intubation [2–4]. However, there is limited evidence on the most appropriate form of noninvasive respiratory support in the different ARF scenarios. While HFNC is more comfortable and tolerated when compared to COT and to

- Its ability to unload respiratory muscles in ARF may be lower than that provided by NIV.

- Moreover, prolonging noninvasive respiratory support in patients failing with either HFNC and NIV may result in delayed intubation and worsen hospital mortality

HFNC

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- Airflows as high as 50–60 L·min−1
- HFNC closely matches the inspiratory demands of dyspnoeic patients
- Achieves an FiO_2 as high as 100%
- A low level of (PEEP) in the upper airways, facilitating alveolar recruitment
- Decreased risk of P-SILI
- Avoiding harmful changes in transpulmonary pressure
- Carbon dioxide washout of upper airways
- Improved ventilation and provision of reliable humidification
- Increased patient comfort and enhanced secretion clearance
- This is particularly true for immunocompromised patients who are more likely to develop complications correlated to IMV, such as ventilator-associated pneumonia (VAP)

Recommendations in GRADE

	For patients	For clinicians	For policy makers
Strong *"We recommend…"*	Most individuals in this situation would want the recommended course of action and only a small proportion would not.	Most individuals should receive the recommended course of action. Could be a quality indicator. Decision aid not needed.	The recommendation can be adapted as policy in most situations including for the use as performance indicators.
Weak/conditional *"We suggest…"*	The majority of individuals in this situation would want the suggested course of action, but many would not.	Different choices will be appropriate for different patients, need to help each patient arrive at a management decision consistent with her or his values and preferences.	Policy making will require substantial debates and involvement of many stakeholders. Policy may vary between regions.

Adapted from the GRADE handbook

Recommendations in GRADE

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Adapted from the GRADE handbook

PICO Questions

TABLE 2 Population, intervention, comparison, outcomes (PICO) questions and recommendations

1. Should HFNC or COT be used in patients with acute hypoxaemic respiratory failure?	The ERS task force suggests the use of HFNC over COT in patients with acute hypoxaemic respiratory failure (conditional recommendation, moderate certainty of evidence)
2. Should HFNC or NIV be used in patients with acute hypoxaemic respiratory failure?	The ERS task force suggests the use of HFNC over NIV in acute hypoxaemic respiratory failure (conditional recommendation, very low certainty of evidence)
3. Should HFNC or COT be used during breaks from NIV in patients with acute hypoxaemic respiratory failure?	The ERS task force suggests the use of HFNC over COT during breaks from NIV in patients with acute hypoxaemic respiratory failure (conditional recommendation, low certainty of evidence)
4. Should HFNC or COT be used in post-operative patients after extubation?	The ERS task force suggests the use of either COT or HFNC in post-operative patients at low risk of respiratory complications (conditional recommendation, low certainty of evidence)
5. Should HFNC or NIV be used in post-operative patients after extubation?	The ERS task force suggests the use of either HFNC or NIV in post-operative patients at high risk of respiratory complications (conditional recommendation, low certainty of evidence)
6. Should HFNC or COT be used in nonsurgical patients after extubation?	The ERS task force suggests the use of HFNC over COT in nonsurgical patients after extubation (conditional recommendation, low certainty of evidence)
7. Should HFNC or NIV be used in nonsurgical patients after extubation?	The ERS task force suggests the use of NIV over HFNC for patients at high risk of extubation failure, unless there are absolute or relative contraindications to NIV (conditional recommendation, moderate certainty of evidence)
8. Should HFNC or NIV be used in patients with acute hypercapnic respiratory failure?	The ERS task force suggests a trial of NIV prior to use of HFNC in patients with COPD and acute hypercapnic respiratory failure (conditional recommendation, low certainty of evidence)

HFNC: high-flow nasal cannula; COT: conventional oxygen therapy; NIV: noninvasive ventilation; ERS: European Respiratory Society.

1. HFNC in Hypoxemic resp failure

Recommendation 1. We suggest use of HFNC over COT in adults with acute hypoxemic respiratory failure

(conditional recommendation, moderate certainty of evidence)

Critical outcomes	Studies	Relative risk	Absolute risk	Certainty of evidence
Mortality	6 RCTs n=1507	RR 0.99 (0.84 to 1.17)	3 fewer per 1,000 (from 41 fewer to 43 more)	**Moderate** *Limited by imprecision*
Intubation	11 RCTs n=1850	RR 0.89 (0.77 to 1.02)	31 fewer per 1,000 (from 64 fewer to 6 more)	
Escalation to NIV	6 RCTs n=797	RR 0.76 (0.43 to 1.34)	29 fewer per 1,000 (from 69 fewer to 41 more)	

Non-critical outcomes: improved patient comfort, dyspnea, respiratory rate, PaO2, P/F; no difference in PCO2
The impact on mortality is probably small (<1%).

Justification

- HFNC is most likely to benefit patients who are at high risk of intubation;
- its use should be favoured in patients with more severe disease rather than patients requiring low oxygen flow rates,
- in those with severe symptoms, given the improvements in patient comfort, dyspnoea, respiratory rate, and gas exchange.
- The panel notes that AHRF, particularly ARDS, is heterogenous: identifying patients most likely to benefit from HFNC requires clinician judgement

1. HFNC in Hypoxemic resp failure

Recommendation 1. We suggest use of HFNC over COT in adults with acute hypoxemic respiratory failure

(conditional recommendation, moderate certainty of evidence)

Justification for recommendation:

- Balance of effects favour HFNC, especially intubation, though some uncertainty; biggest impact likely in patients at high risk of intubation
- No major tradeoffs or variation in patient preferences identified
- Resource considerations likely between centres (devices, O2 use, monitoring)
- Widespread use demonstrates feasibility and acceptability of device

1. HFNC in Hypoxemic resp failure

Recommendation 2: We suggest use of HFNC over NIV in patients with acute hypoxemic respiratory failure

(conditional recommendation, very low certainty of evidence)

Critical outcomes	Studies	Relative risk	Absolute risk	Certainty of evidence
Mortality	3 RCT n=474	RR 0.77 (0.52 to 1.14)	45 fewer per 1,000 (from 94 fewer to 27 more)	**Very low** *Limited by indirectness, imprecision*
Intubation	5 RCT n=708	RR 0.84 (0.61 to 1.16)	41 fewer per 1,000 (from 101 fewer to 41 more)	**Low** *Limited by imprecision*

Non-critical outcomes: HFNC increased comfort, but also more dyspnea than NIV; increased PaO2 and P/F; similar PCO2 and RR . Reassuringly, for almost every outcome (other than dyspnoea), HFNC appeared to be beneficial or at least neutral compared to NIV.

Subgroup considerations

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- Benefits of HNFC may be greater in immunocompromised patients. However, these results are entirely derived from one study and remain imprecise, and judged insufficient for a strong recommendation.
- The task force chose to make only a single recommendation.
- No RCTs comparing HFNC to NIV in COVID-19 were available, and the panel choose not to make a separate recommendation.
- New paper it found no differences in respiratory support-free days or mortality at 30 or 60 days, but a reduction in intubation at 28 days .
- While suggesting that helmet NIV may reduce intubation compared to HFNC in COVID-19, it is interesting that mortality between the groups is unchanged.
- While this study demonstrates the viability of both devices in COVID-19, further research is needed before a definitive recommendation can be issued, especially as helmet NIV is not available in all centres and such a recommendation would require substantial change in practice for many hospitals.

1. HFNC in Hypoxemic resp failure

Recommendation 2: We suggest use of HFNC over NIV in patients with acute hypoxemic respiratory failure

(conditional recommendation, very low certainty of evidence)

Justification for recommendation:

- Balance of effects favour HFNC, though less certainty when compared to COT
- in some cases clinicians may judge that NIV is preferred (eg. previous use/tolerance of HFNC/NIV; suspected OSA; absence of secretions, etc)

Background

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- **HFNC and NIV are used more frequently in patients with progressive or moderate to severe AHRF (PaO2 / FiO2 ⩽200 mmHg), when the risks of intubation and death are higher .**

- **In more severe AHRF (PaO2 /FiO2 <=100clinicians aim to balance the benefits together with its complications versus the harms of delayed intubation, including high inspiratory effort, increased lung stress and risk of lung injury during noninvasive respiratory support**

- **HFNC is an attractive alternative to NIV for treating patients with AHRF and high respiratory demand.**

1. HFNC in Hypoxemic resp failure

Recommendation 3: We suggest use of HFNC over COT during breaks from NIV in patients with acute hypoxemic respiratory failure

(conditional recommendation, very low certainty of evidence)

Justification for recommendation:

- Single study, underpowered for critical outcomes, but similar intubation rate (2/28 vs 0/26, p=0.49); patient comfort, respiratory rate, and dyspnea lower with HFNC
- Considering indirect evidence from recommendation 1, there may be a small benefit to HFNC over COT during breaks from patients on NIV; unlikely to be impact on mortality, intubation given short duration of intervention
- HFNC suggested over COT, where resources permit, on basis of comfort and dyspnea

2. HFNC in Postoperative patients

Recommendation 4: We suggest the use of either COT or HFNC in postoperative patients at low risk of respiratory complications

(conditional recommendation, low certainty of evidence)

Critical outcomes	Studies	Relative risk	Absolute risk	Certainty of evidence
Mortality	7 RCTs n=1049	RR 0.64 (0.19 to 2.14)	5 fewer per 1,000 (from 11 fewer to 15 more)	**Moderate** *Limited by imprecision*
Intubation	8 RCTs n=1201	RR 0.66 (0.23 to 1.91)	12 fewer per 1,000 (from 28 fewer to 33 more)	**Low** *Limited by risk of bias, imprecision*
Escalation to NIV	7 RCTs n=1110	RR 0.77 (0.42 to 1.40)	27 fewer per 1,000 (from 68 fewer to 47 more)	**Very low** *Limited by risk of bias, inconsistency, imprecision*

Non-critical outcomes: little effect upon comfort, but higher PaO2 and P/F with HFNC; no effect PCO2 or RR

2. HFNC in Postoperative patients

IR/OTH/2022/0016

Recommendation 4: We suggest the use of either COT or HFNC in postoperative patients at low risk of respiratory complications

(conditional recommendation, low certainty of evidence)

Justification for recommendation:

- Balance of effects favour HFNC but absolute effects are very small and uncertain, without improvements in comfort and dyspnea
- Given lack of certainty of effects, use of COT or HFNC is reasonable, primarily driven by resource considerations (HFNC generally more intensive) in this low risk population

2. HFNC in Postoperative patients

Recommendation 5: We suggest either HFNC or NIV in post-operative patients at high risk of respiratory complications

(conditional recommendation, low certainty of evidence)

Critical outcomes	Studies	Relative risk	Absolute risk	Certainty of evidence
Mortality	1 RCT n=830	RR 1.22 (0.72 to 2.09)	12 more per 1,000 (from 15 fewer to 60 more)	**Moderate** *Limited by imprecision*
Intubation	1 RCT n=830	RR 1.02 (0.73 to 1.44)	3 more per 1,000 (from 37 fewer to 60 more)	**Low** *Limited by risk of bias, imprecision*

Non-critical outcomes: PaO2 and P/F higher with NIV, similar PCO2 and RR

2. HFNC in Postoperative patients

Recommendation 5: We suggest either HFNC or NIV in post-operative patients at high risk of respiratory complications

(conditional recommendation, low certainty of evidence)

Justification for recommendation:

- Single trial of patients at risk of respiratory failure after cardiothoracic surgery, with point estimates favoring NIV but absolute effects may be small
- Given low certainty of effects, either HFNC or NIV appear to be reasonable for use in post-operative patients at high risk of respiratory complications
- Individual patient, center, and resource considerations are likely to play a role in deciding which form of respiratory support to use

3. HFNC post-extubation

Recommendation 6: We suggest HFNC over COT in non-surgical patients after extubation at low or moderate risk of extubation failure

(conditional recommendation, low certainty of evidence)

Critical outcomes	Studies	Relative risk	Absolute risk	Certainty of evidence
Mortality	9 RCTs n= 998	RR 1.01 (0.68 to 1.52)	1 more per 1,000 (from 27 fewer to 43 more)	**Moderate** *Limited by imprecision*
Intubation	10 RCTs n= 1127	RR 0.62 (0.38 to 1.01)	51 fewer per 1,000 (from 82 fewer to 1 more)	**Moderate** *Limited by risk of bias*
Escalation to NIV	6 RCTs n= 525	RR 0.38 (0.17 to 0.85)	94 fewer per 1,000 (from 125 fewer to 23 fewer)	**Moderate** *Limited by risk of bias*

Non-critical outcomes: Improved comfort, PaO2, P/F, with similar PCO2

3. HFNC post-extubation

Recommendation 6: We suggest HFNC over COT in non-surgical patients after extubation at low or moderate risk of extubation failure

(conditional recommendation, low certainty of evidence)

Justification for recommendation:

- Balance of effects favor HFNC, especially intubation and escalation to NIV, but still some uncertainty
- Resource use primary consideration when deciding who to extubate to HFNC, and this will likely vary between centers

3. HFNC post-extubation

Recommendation 7: We suggest the use of NIV over HFNC after extubation for patients at high risk of extubation failure unless there are relative or absolute contraindications to NIV

(conditional recommendation, moderate certainty of evidence)

Critical outcomes	Studies	Relative risk	Absolute risk	Certainty of evidence
Mortality	5 RCTs n= 1513	RR 1.07 (0.84 to 1.36)	10 more per 1,000 (from 23 fewer to 51 more)	**Moderate** *Limited by imprecision*
Intubation	5 RCTs n= 1549	RR 1.31 (1.04 to 1.64)	44 more per 1,000 (from 6 more to 92 more)	**High** *Limited by risk of bias*

Non-critical outcomes: HFNC results in more comfort, with similar PCO2, PaO2, P/F, and RR

3. HFNC post-extubation

Recommendation 7: We suggest the use of NIV over HFNC after extubation for patients at high risk of extubation failure unless there are relative or absolute contraindications to NIV

(conditional recommendation, moderate certainty of evidence)

Justification for recommendation:

- Balance of effects favour NIV, especially reintubation, though comfort higher with HFNC
- TF judged most patient would prefer to avoid intubation despite increased comfort with HFNC
- Some patients may have relative or absolute contraindications to NIV, in which case HFNC would be a reasonable alternative

4. HFNC in hypercapnic resp failure

Recommendation 8: We suggest a trial of NIV prior to use of HFNC in patients with COPD and acute hypercapnic respiratory failure

(conditional recommendation, low certainty of evidence)

Critical outcomes	Studies	Relative risk	Absolute risk	Certainty of evidence
Mortality	4 RCTs n= 250	RR 0.82 (0.46 to 1.47)	31 fewer per 1,000 (from 92 fewer to 80 more)	**Low** *Limited by very serious imprecision*
Intubation	4 RCTs n= 275	RR 0.79 (0.46 to 1.35)	36 fewer per 1,000 (from 93 fewer to 60 more)	**Low** *Limited by very serious imprecision*

Non-critical outcomes: more comfort with HFNC but similar dyspnea, PaO_2, P/F, PCO_2, RR

4. HFNC in hypercapnic resp failure

Recommendation 8: We suggest a trial of NIV prior to use of HFNC in patients with COPD and acute hypercapnic respiratory failure

(conditional recommendation, low certainty of evidence)

Justification for recommendation:

- Certainty of evidence comparing HFNC and NIV is low, but suggests similar effects; cf. evidence for NIV with hypercapnic COPD is high; TF judged more evidence is needed before HFNC can be considered first line treatment
- In most patients with acute hypercapnic resp failure, a trial of NIV is warranted; many patients will rapidly improve and can be de-escalated to HFNC; patients who do not tolerate NIV can trial HFNC
- Other considerations similar to other HFNC/NIV comparisons

Future Research

TABLE 3 Key research recommendations	
1. Should HFNC or COT be used in patients with acute hypoxaemic respiratory failure?	More evidence is needed to identify patients at high risk of deterioration and therefore more likely to benefit from HFNC. Which treatment (HFNC or COT) results in aerosolisation of infectious particles in COVID-19, and what are the clinical implications of this?
2. Should HFNC or NIV be used in patients with acute hypoxaemic respiratory failure?	More evidence is needed to assess the impact of HFNC *versus* NIV in COVID-19 and other viral illnesses, as well as in patients at different risk of induced lung injury and different P_{aO_2}/F_{IO_2} ratio severity. More evidence is needed regarding effectiveness of HFNC *versus* NIV in both helmet and facemask forms. Which treatment (HFNC or COT) results in aerosolisation of infectious particles in COVID-19, and what are the clinical implications of this?
3. Should HFNC or COT be used during breaks from NIV in patients with acute hypoxaemic respiratory failure?	More evidence is needed to identify patients who are likely to benefit from HFNC during breaks from NIV (hypoxic and hypercapnic populations).
4. Should HFNC or COT be used in post-operative patients after extubation?	More evidence is needed to identify which patients (type of surgery, comorbidities, P_{aO_2}/F_{IO_2} level) are most likely to benefit from HFNC over COT when used post-operatively according to different settings (high- *versus* low-intensity monitoring); however, it is likely that any such effects in low-risk groups will be small.
5. Should HFNC or NIV be used in post-operative patients after extubation?	Further large RCTs are needed to compare NIV and HFNC in different subgroups of surgical patients according to different settings (high- *versus* low-intensity monitoring). Additional research is needed to identify the subgroups of post-operative patients at high risk of respiratory failure most likely to benefit from use of combination treatment (NIV plus HFNC) *versus* NIV alone.
6. Should HFNC or COT be used in nonsurgical patients after extubation?	More evidence is needed to identify which patients (underlying disease, comorbidities, P_{aO_2}/F_{IO_2} level) according to different settings (high- *versus* low-intensity monitoring) are most likely to benefit from post extubation HFNC over COT.
7. Should HFNC or NIV be used in nonsurgical patients after extubation?	More evidence is needed to identify which patients (underlying disease, comorbidities, P_{aO_2}/F_{IO_2} level) according to different settings (high- *versus* low-intensity monitoring) are most likely to benefit from post-extubation HFNC over COT are most likely to benefit from NIV over HFNC.
8. Should HFNC or NIV be used in patients with acute hypercapnic respiratory failure?	More randomised data are required to determine populations where HFNC can be a first-line alternative to NIV (*e.g.* severity of COPD; patients with hypercapnic failure from causes other than COPD; hypersecretion, poor mask tolerance, agitation). More evidence needed to predict which patients are likely to successfully transition to HFNC from NIV.

HFNC: high-flow nasal cannula; COT: conventional oxygen therapy; NIV: noninvasive ventilation; COVID-19: coronavirus disease 2019; P_{aO_2}: arterial oxygen partial pressure; F_{IO_2}: inspiratory oxygen fraction; RCT: randomised controlled trial.

Thank You

Case 1

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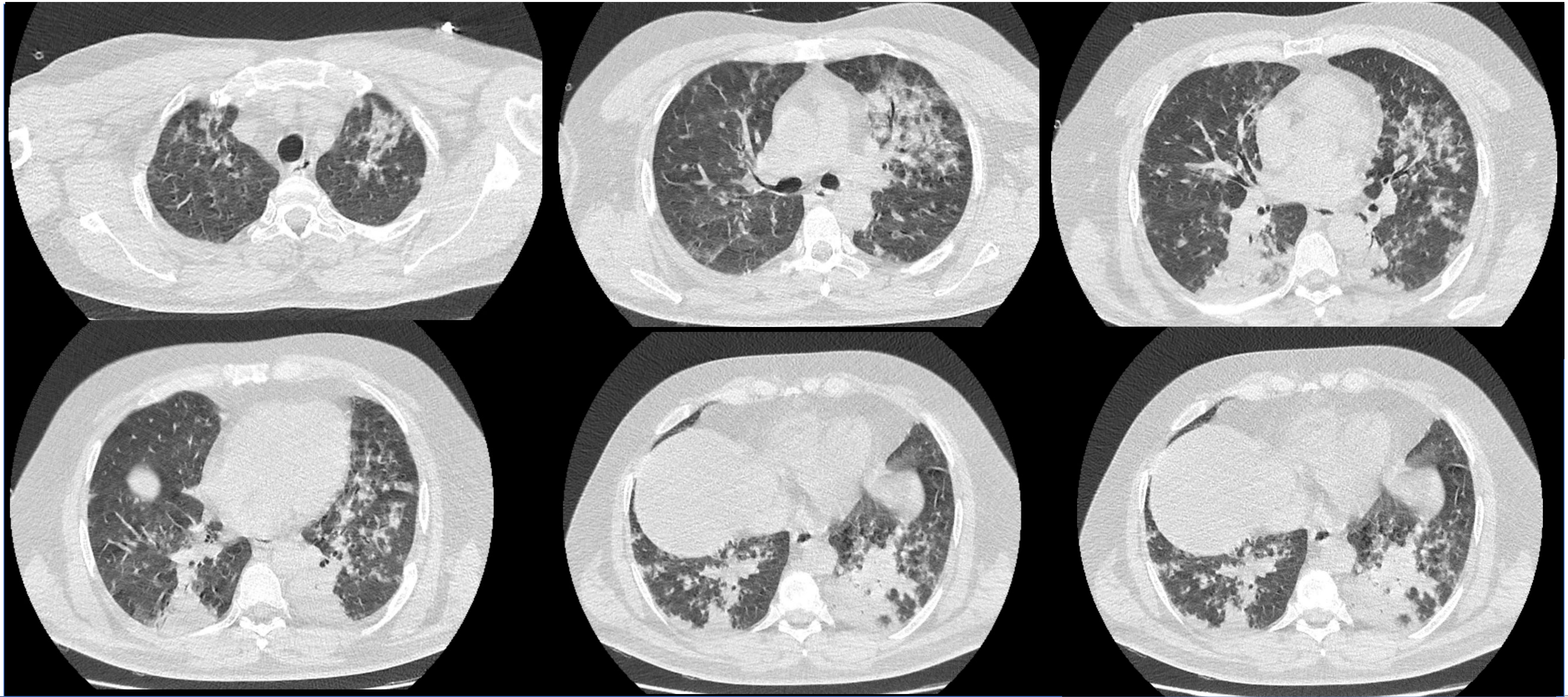
- ✓ 43yo male, with a past medical history of epilepsy
- ✓ Epileptic seizure while swimming in the sea
- ✓ Taken to the shore around 5 minutes, no CPR needed
- ✓ Transfer to emergency room and directly supported with oxygen
  - GCS score 15
  - Body temp:36^{0}C, BP:126/82mmHg, pulse:118/m, RR:28/m SpO2 82%
  - Bilateral crackles on auscultation

Case 1 Thorax CT



Case 1- Arterial blood gas values after initial evaluation

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pH: 7.35

$PaCO_2$: 31mmHg

HCO_3: 19.7mEq/L

PaO_2: 68mmHg

$SatO_2$: 92%

Mask O_2 6-8L/m

Case 1- Arterial blood gas values after initial evaluation

pH: 7.35

$PaCO_2$: 31mmHg

HCO_3: 19.7mEq/L

PaO_2: 68mmHg

$SatO_2$: 92%

Mask O_2 6-8L/m

ARF due to drowning

PaO_2/FiO_2 ratio <150

No PEEP

ARDS???

Transfer to ICU

Question

If you were the ICU physician, would you intubate the patient?

(ARDS? P/F< 150, GCS 15, Good response to oxygen therapy)

1. Yes
2. No

Question

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If you were the ICU physician, would you intubate the patient?
(ARDS? P/F< 150, GCS 15, Good response to oxygen therapy)

1. Yes
2. No

Question

Your choice for respiratory support would be….

1. Conventional oxygen therapy (COT)
2. High-flow nasal cannula (HFNC)
3. Noninvasive ventilation (NIV)

Why HFNC in acute hypoxemic RF? (recommendation 1)

Especially in patients with severe ARF at high risk of intubation

Compared to COT:

- ✓ Reduce intubation
- ✓ Reduce escalation to NIV
- ✓ Decrease dyspnea
- ✓ Increase comfort
- ✓ Improve gas exchange
- ✓ Mortality similar

NIV in acute hypoxemic respiratory failure
(recommendation 2)

Compared to NIV, HFNC appeared to be beneficial for critical outcomes such as intubation and mortality!

Major concerns!

- **Heterogeneity of limited n of studies and reported outcomes**
- **True effect of NIV is still uncertain➔ Duration and support level of NIV**
- **Risk of VILI with high tidal volumes / Helmet NIV? (HENIVOT trial)**

Question

How do you monitor response to HFNC therapy?

① Clinical parameters (RR, signs of respiratory distress, oxygenation, signs of disease progression)

② ROX index

③ Both

MONITOR THERAPY!
Up to 30-40% of patients with severe AHRF fail

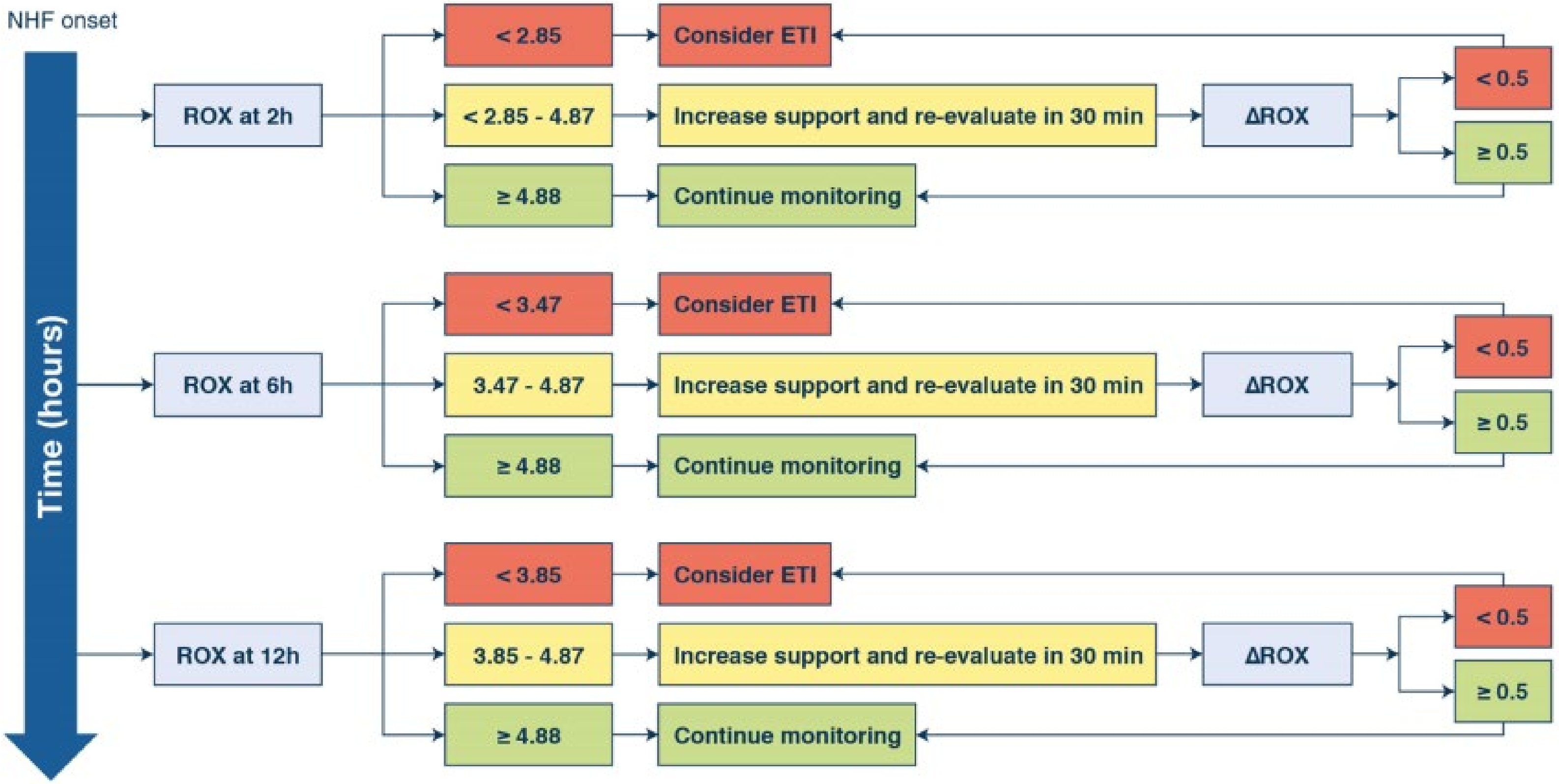
Intensive Care Med (2020) 46:2238–2247
https://doi.org/10.1007/s00134-020-06228-7

NARRATIVE REVIEW

Use of nasal high flow oxygen during acute respiratory failure

Jean-Damien Ricard[1,2*], Oriol Roca[3,4], Virginie Lemiale[5], Amanda Corley[6,7], Jens Braunlich[8,9], Peter Jones[10,11], Byung Ju Kang[12], François Lellouche[13], Stefano Nava[14], Nuttapol Rittayamai[15], Giulia Spoletini[16,17], Samir Jaber[18] and Gonzalo Hernandez[19]

- **Clinical judgment**
- **ROX index**



ROX index validated in patients with pneumonia-related AHRF.

Case 1- supported by HFNC

Flow 50L/m FiO2 50%

After couple of hours RR 25/m SpO2 96%

pH 7.36

$PaCO_2$ 34mmHg

HCO3 20mEq/L

PaO_2 84mmHg

$SatO_2$ 96%

ROX index 7.7

Case 1- supported by HFNC

Flow 50L/m FiO2 50%

After couple of hours RR 25/m SpO2 96%

pH 7.36

$PaCO_2$ 34mmHg

HCO3 20mEq/L

PaO_2 84mmHg

$SatO_2$ 96%

ROX index 7.7

Very well tolerated,

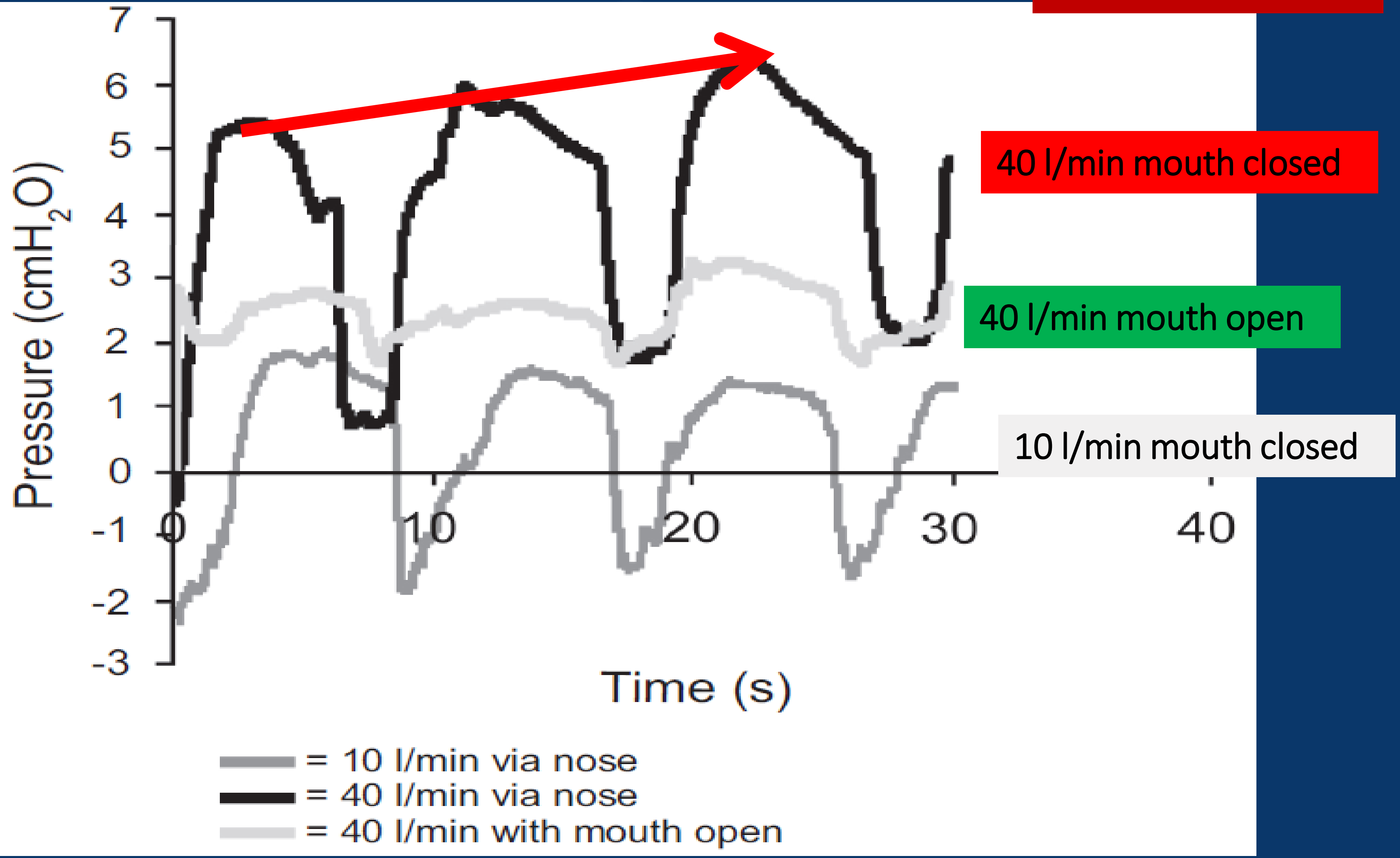
HFNC terminated on day 3, Transferred to pulmonary ward and discharged next day

Evaluation of a humidified nasal high-flow oxygen system, using oxygraphy, capnography and measurement of upper airway pressures

Anaesth Intensive Care 2011; 39: 1103-1110

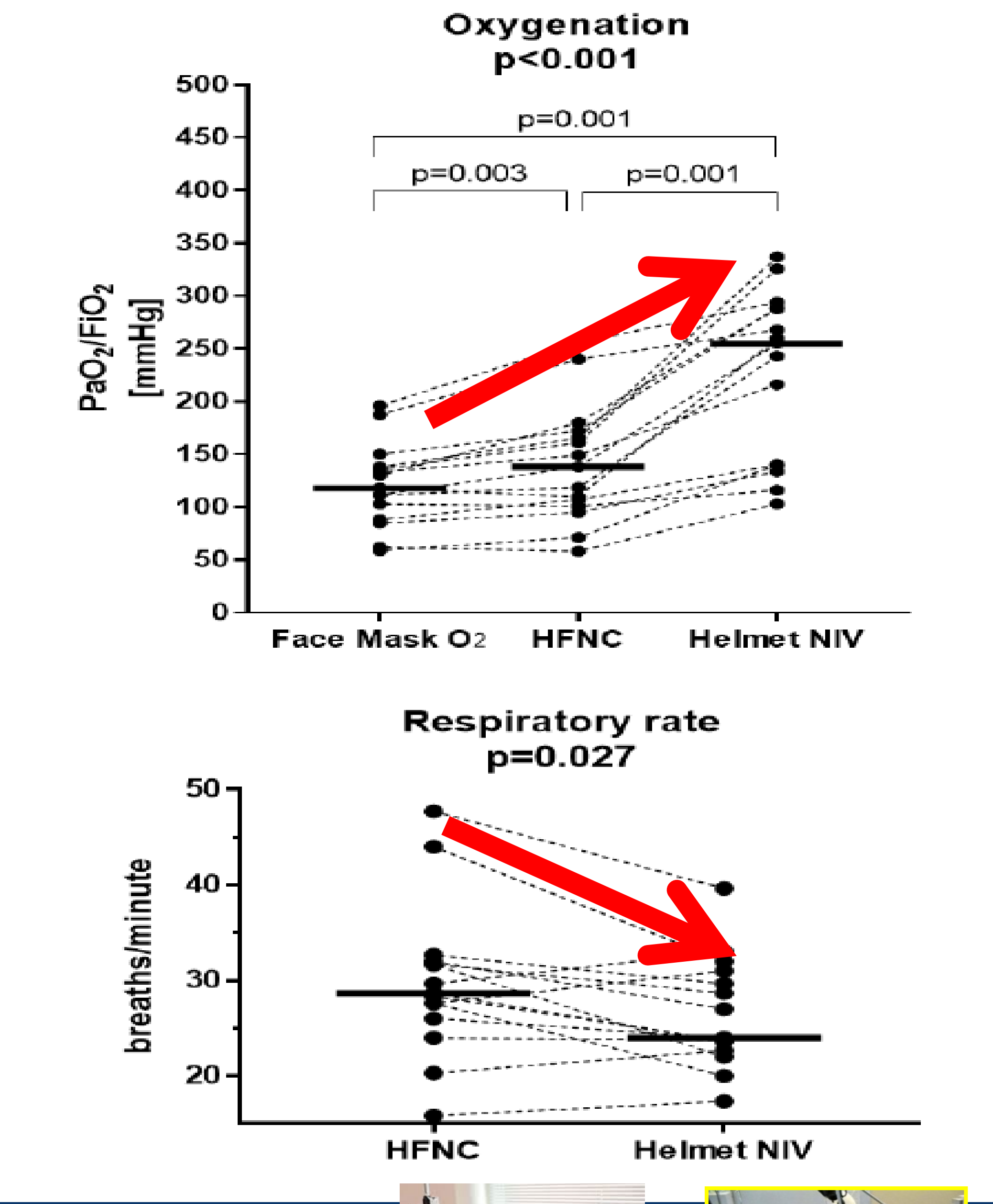
J. E. RITCHIE*, A. B. WILLIAMS†, C. GERARD‡, H. HOCKEY§

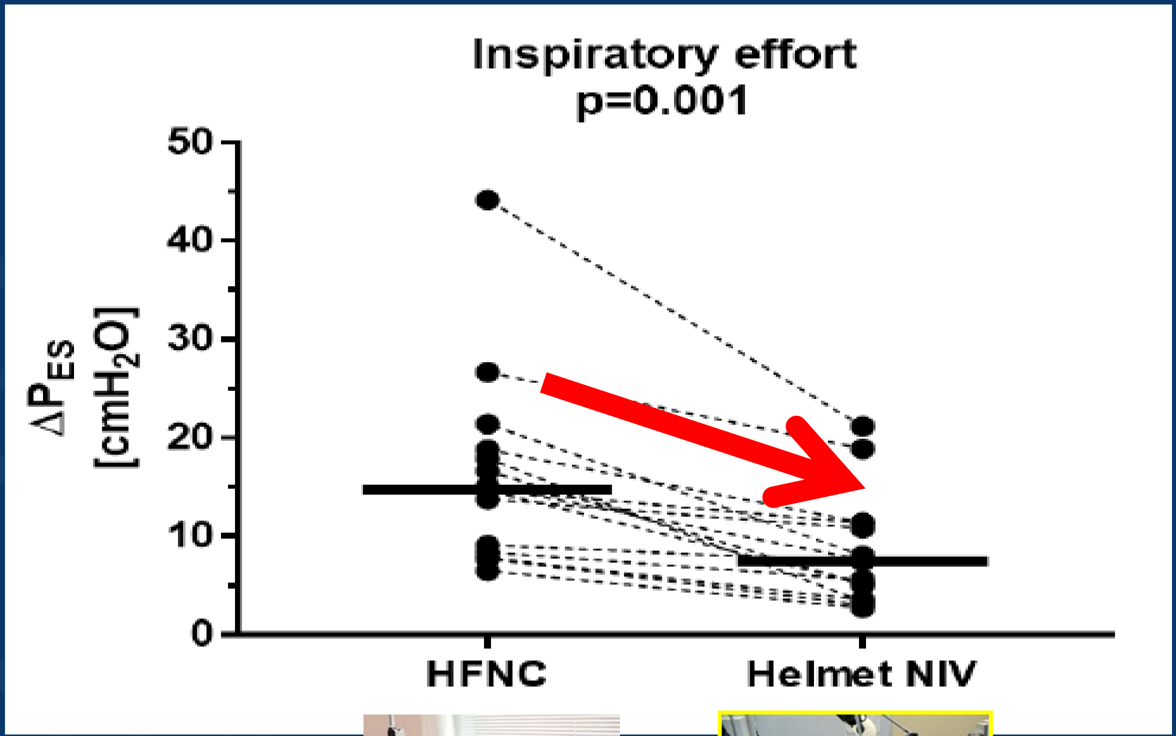
PEEP-EFFECT



COBEL DAROU

HFNC vs NIV-Helmet in Hypoxemia





Grieco DL et al. AJRCCM 2019

COBEL DAROU

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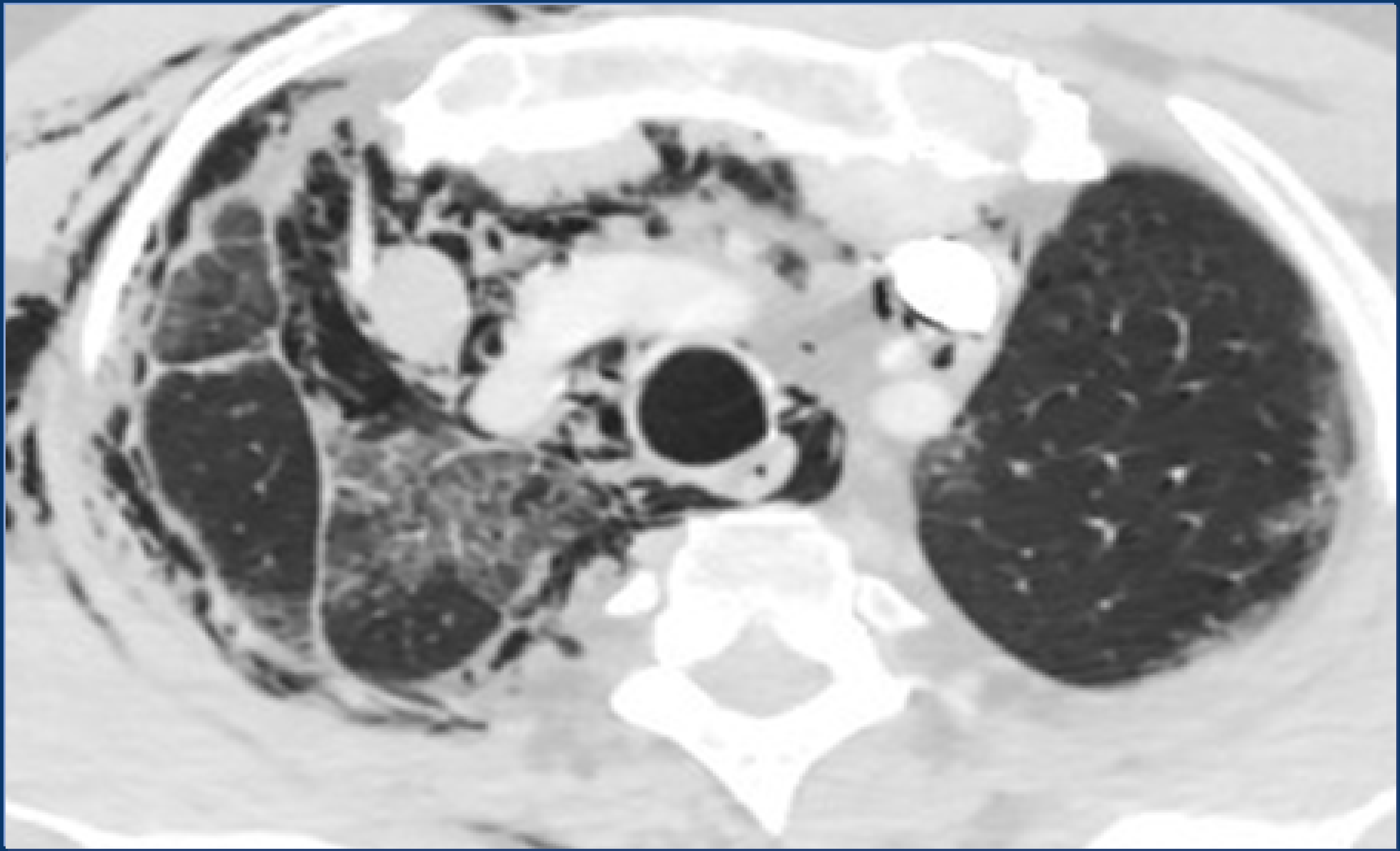
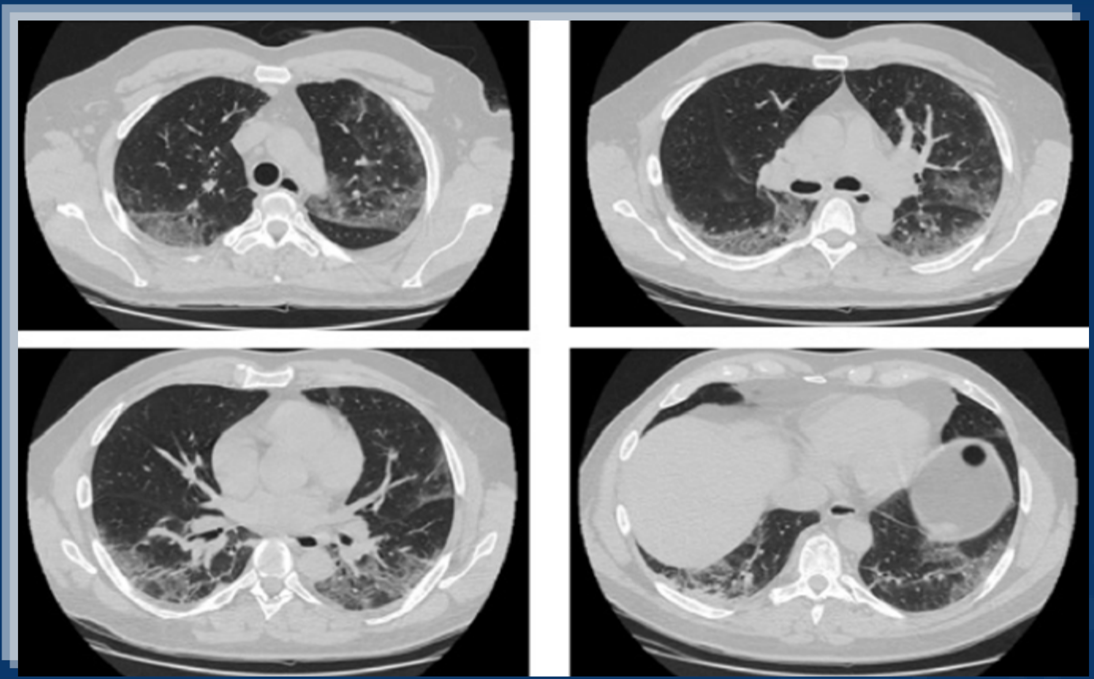
After 12 hrs of CPAP applied to COVID-19 “L”

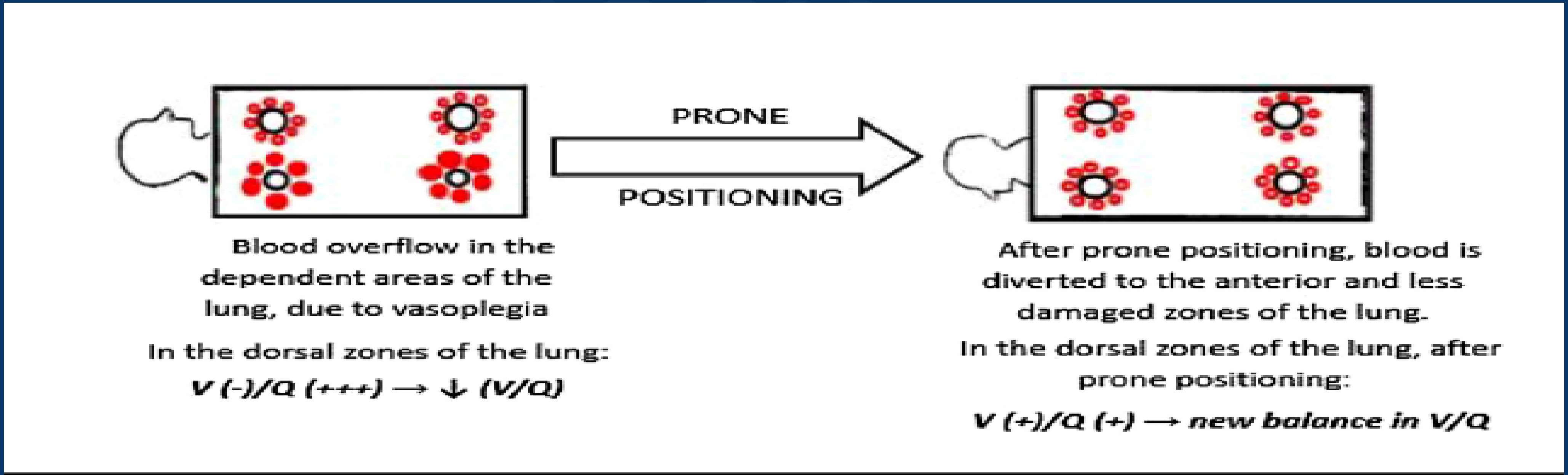




HFNC 50l/min, FiO2 0,50

SUPINE → PRONE

PaO2/FiO2 69 → PaO2/FiO2 203



Oldani S et al, Pulmonology 2021

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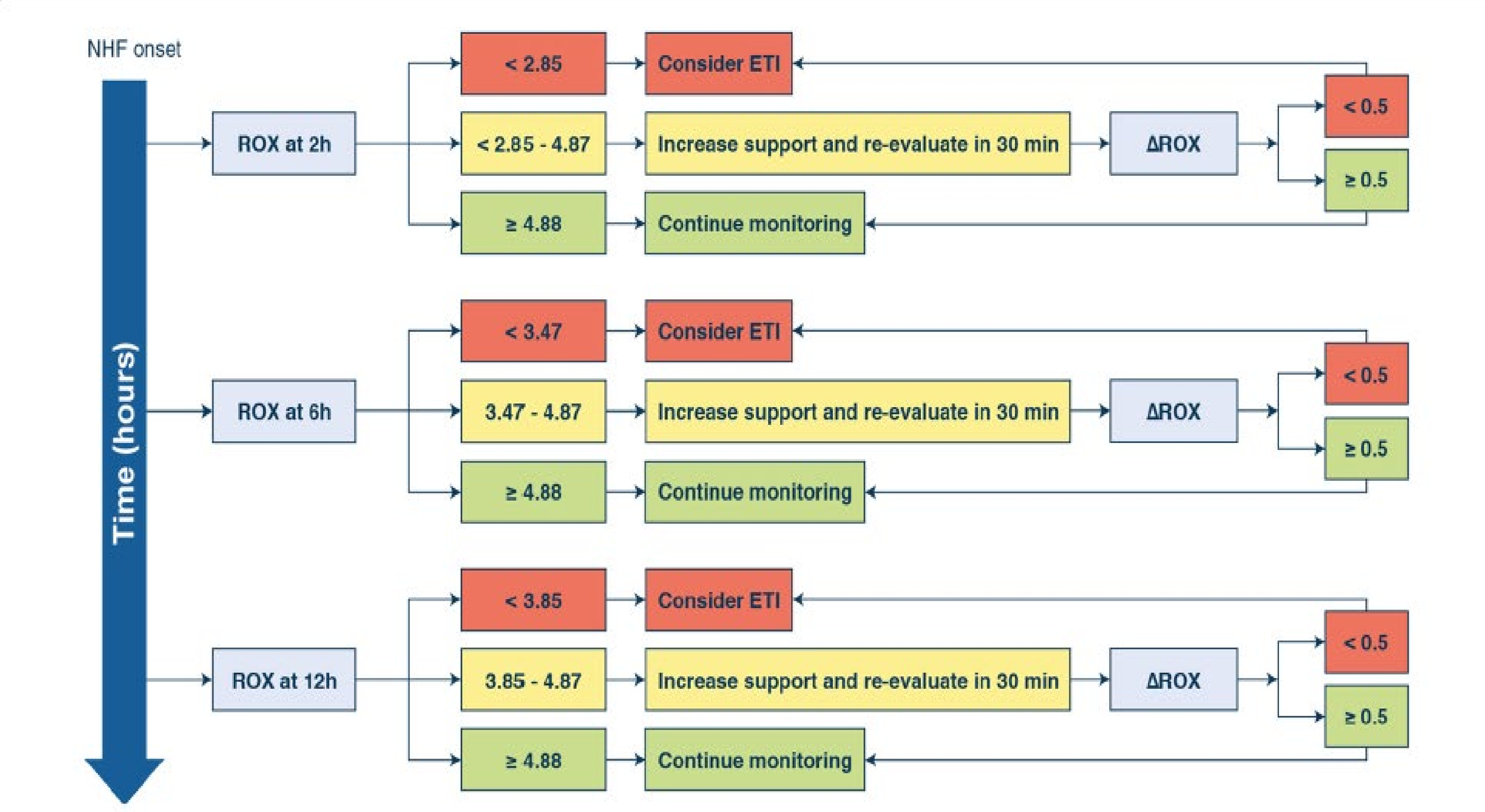

Ricard JD et al Intensive Care Med. 2020

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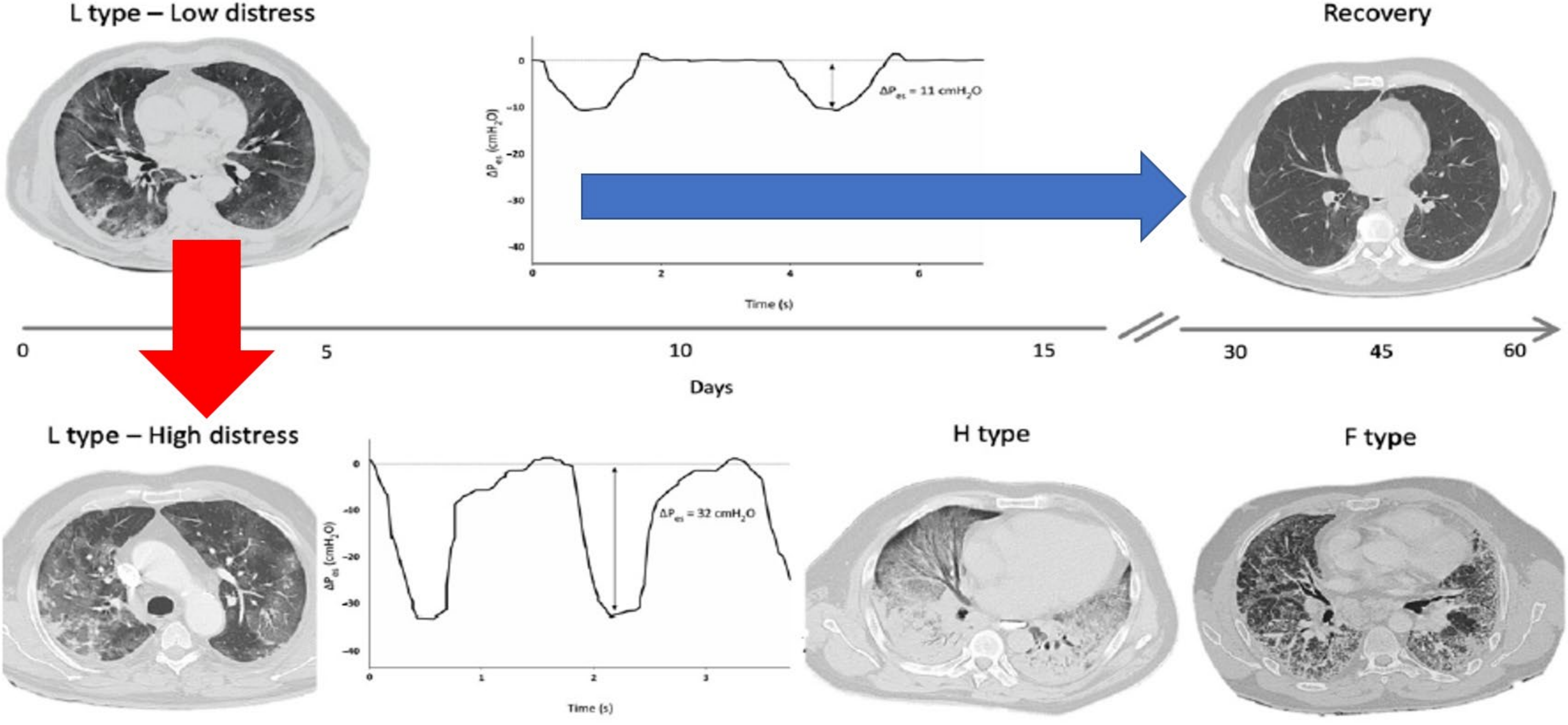
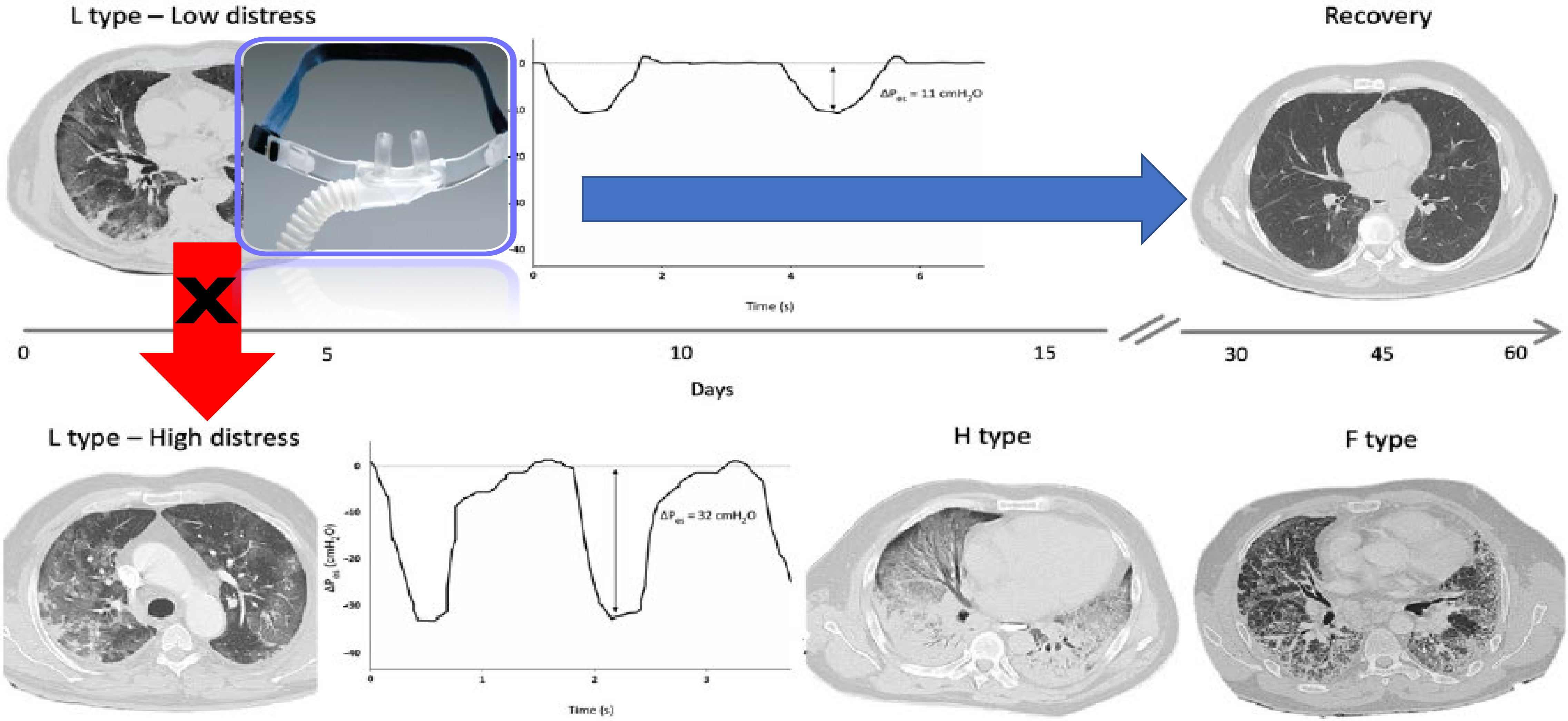
HFNC rationale in COVID-19 correlated ARF



HFNC rationale in COVID-19 correlated ARF



Tonelli R et al. J Clin Med 2021

Thank You

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