Ο ασθενής με οξεία αναπνευστική ανεπάρκεια την εποχή της πανδημίας

ΙΩΑΝΝΑ ΣΙΓΑΛΑ

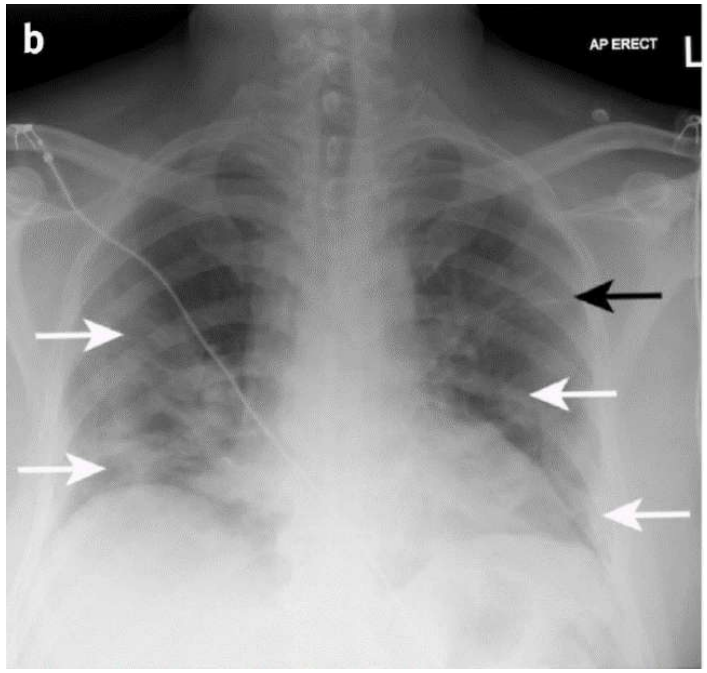
Πνευμονολόγος-Εντατικολόγος

Επιμελήτρια Ά ΕΣΥ

Ά Κλινική Εντατικής Θεραπείας ΕΚΠΑ,

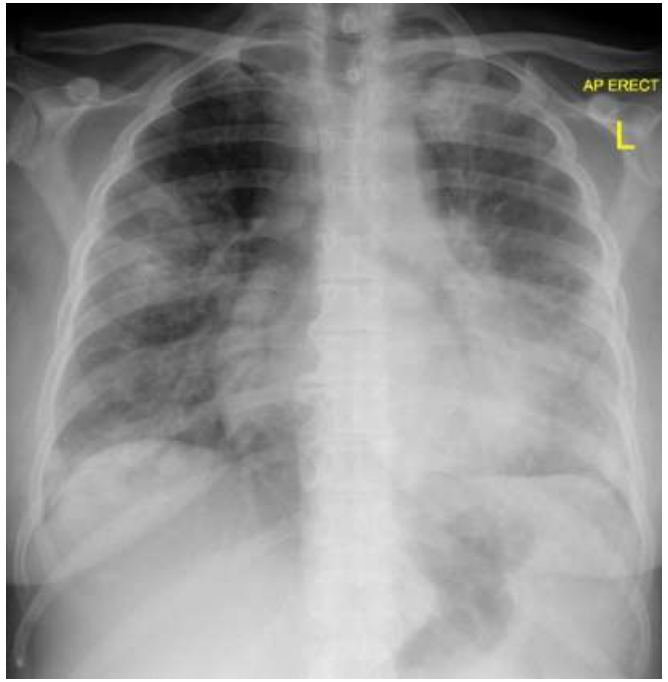
Νοσοκομείο «Ευαγγελισμός»

50YO, FEVER DYSPNOEA, DRY COUGH



65YO, DYSPNOEA, DRY COUGH, NASAL DISCHARGE

70YO, FEVER, DYSPNOEA



ABG: Hypoxamic Respiratory Failure

70YO, DYSPNOEA, COUGH, SPUTUM

87YO, DYSPNOEA, COUGH, SPUTUM

ABG: TYPE II RESPIRATORY FAILURE-RESPIRATORY ACIDOSIS

- Τι έχουν κοινό
- Ποιο είναι το πρωταρχικό ερώτημα
- Η θεραπεία της αναπνευστικής ανεπάρκειας είναι ίδια για όλους
- Αλλάζει κάτι λόγω πανδημίας

Τι έχουν κοινό???

ΟΡΙΣΜΟΙ - ΕΟΔΥ COVID19

Κλινικά κριτήρια

Ασθενής με <u>ένα τουλάχιστον από τα κατωτέρω συμπτώματα</u>

- ❑ **βήχας**
- ❑ **πυρετός**
- ❑ **δύσπνοια**
- ❑ **αιφνίδια εκδήλωση ανοσμίας, αγευσίας ή δυσγευσίας**

Απεικονιστικά διαγνωστικά κριτήρια

- ❑ **Ακτινολογικά ευρήματα συμβατά με COVID-19**

Εργαστηριακά κριτήρια

- ❑ Ανίχνευση νουκλεϊκού οξέος SARS-CoV-2 σε κλινικό δείγμα

Επιδημιολογικά κριτήρια

- ❑ στενή επαφή με επιβεβαιωμένο κρούσμα COVID-19 εντός 14 ημερών πριν την έναρξη συμπτωμάτων
- ❑ φιλοξενούμενοι ή προσωπικό δομών στις οποίες φιλοξενούνται ευάλωτα άτομα και έχει επιβεβαιωθεί συνεχιζόμενη μετάδοσηCOVID-19

Ενδεχόμενο κρούσμα

- ❑ Ασθενής που **πληροί τα κλινικά κριτήρια**

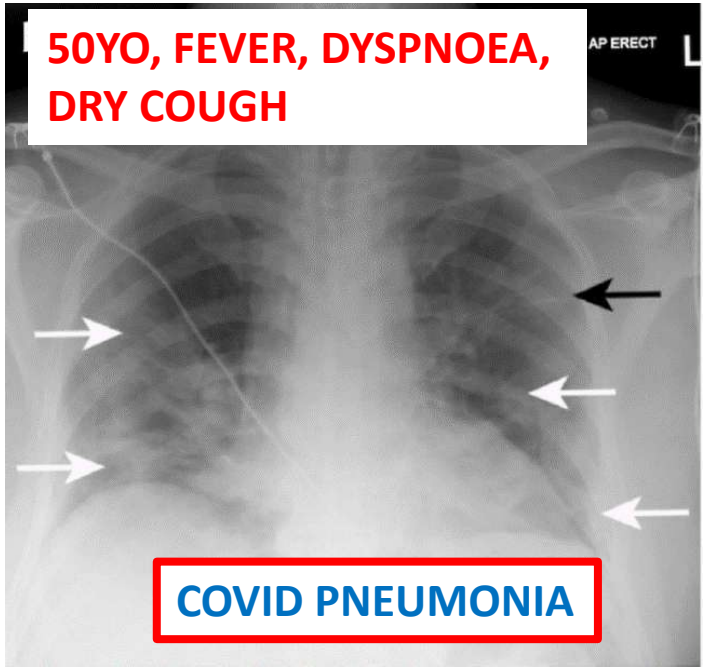
Πιθανό κρούσμα

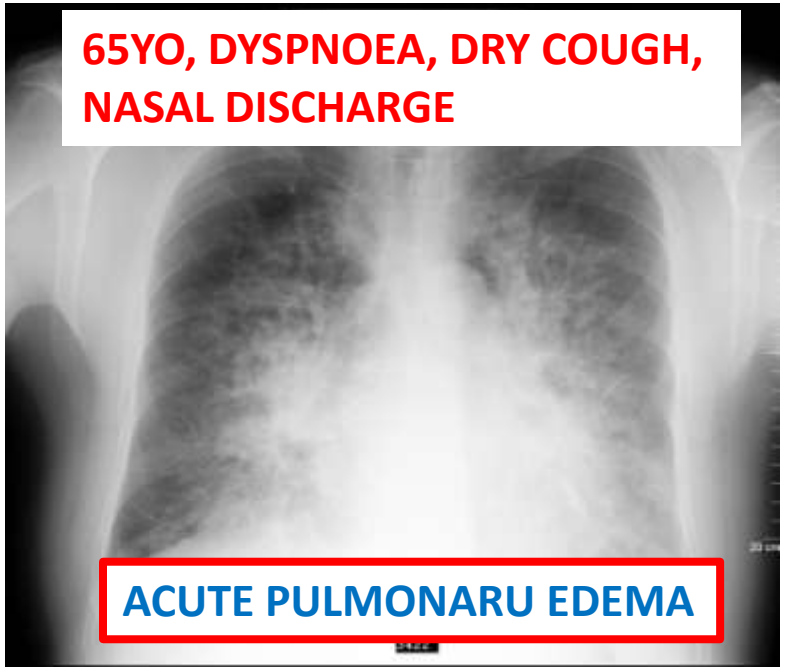
- ❑ Ασθενής που πληροί **τα κλινικά κριτήρια και ένα επιδημιολογικό κριτήριο**
- ❑ Άτομο που **πληροί τα απεικονιστικά διαγνωστικά κριτήρια**

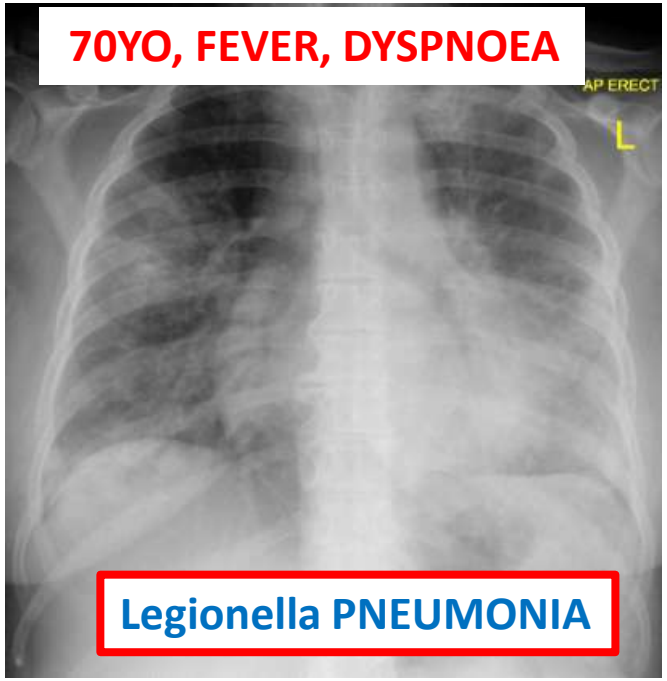
Επιβεβαιωμένο κρούσμα

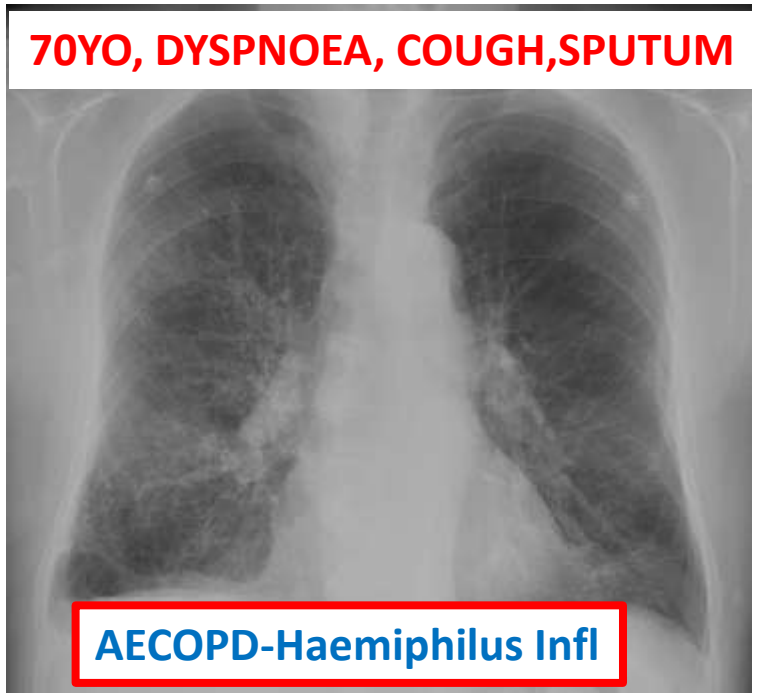
- ❑ Άτομο που **πληροί τα εργαστηριακά κριτήρια**

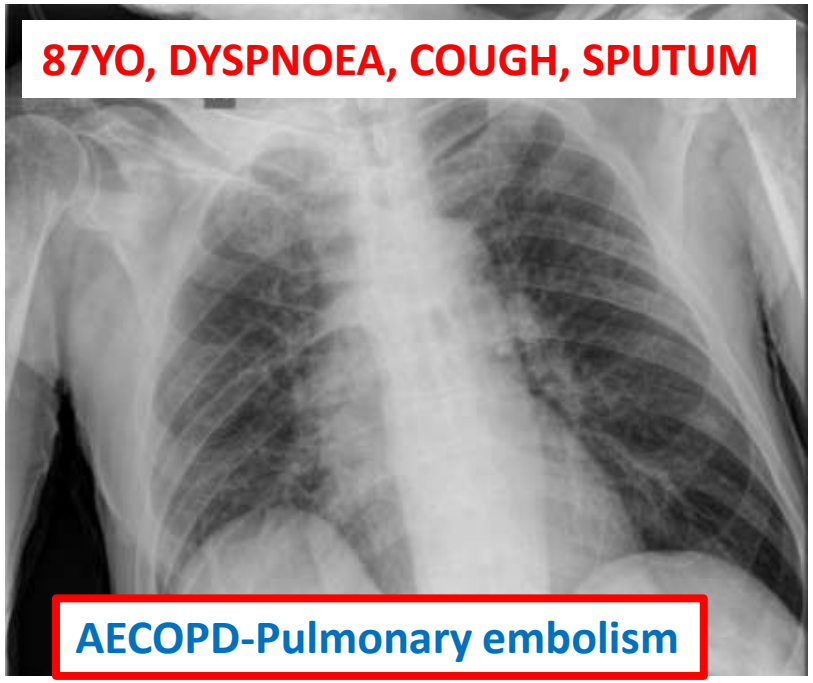
Ποιο είναι το πρωταρχικό ερώτημα ???


50YO, FEVER, DYSPNOEA, DRY COUGH
AP ERECT
L
COVID PNEUMONIA


65YO, DYSPNOEA, DRY COUGH, NASAL DISCHARGE
ACUTE PULMONARU EDEMA


70YO, FEVER, DYSPNOEA
AP ERECT
L
Legionella PNEUMONIA


70YO, DYSPNOEA, COUGH,SPUTUM
AECOPD-Haemiphilus Infl


87YO, DYSPNOEA, COUGH, SPUTUM
AECOPD-Pulmonary embolism

Η θεραπεία της αναπν. ανεπάρκειας είναι ίδια για όλους???

Lung	Compartment	Respiratory pump
Pulmonary failure	Dysfunction	Ventilatory failure
Partial insufficiency $PaO_2 \downarrow PaCO_2$ (↓)	Blood gas analysis	Global insufficiency $PaO_2 \downarrow PaCO_2 \uparrow$
	Treatment	

NIV indication in acute RF

BTS/ICS guidelines 2016

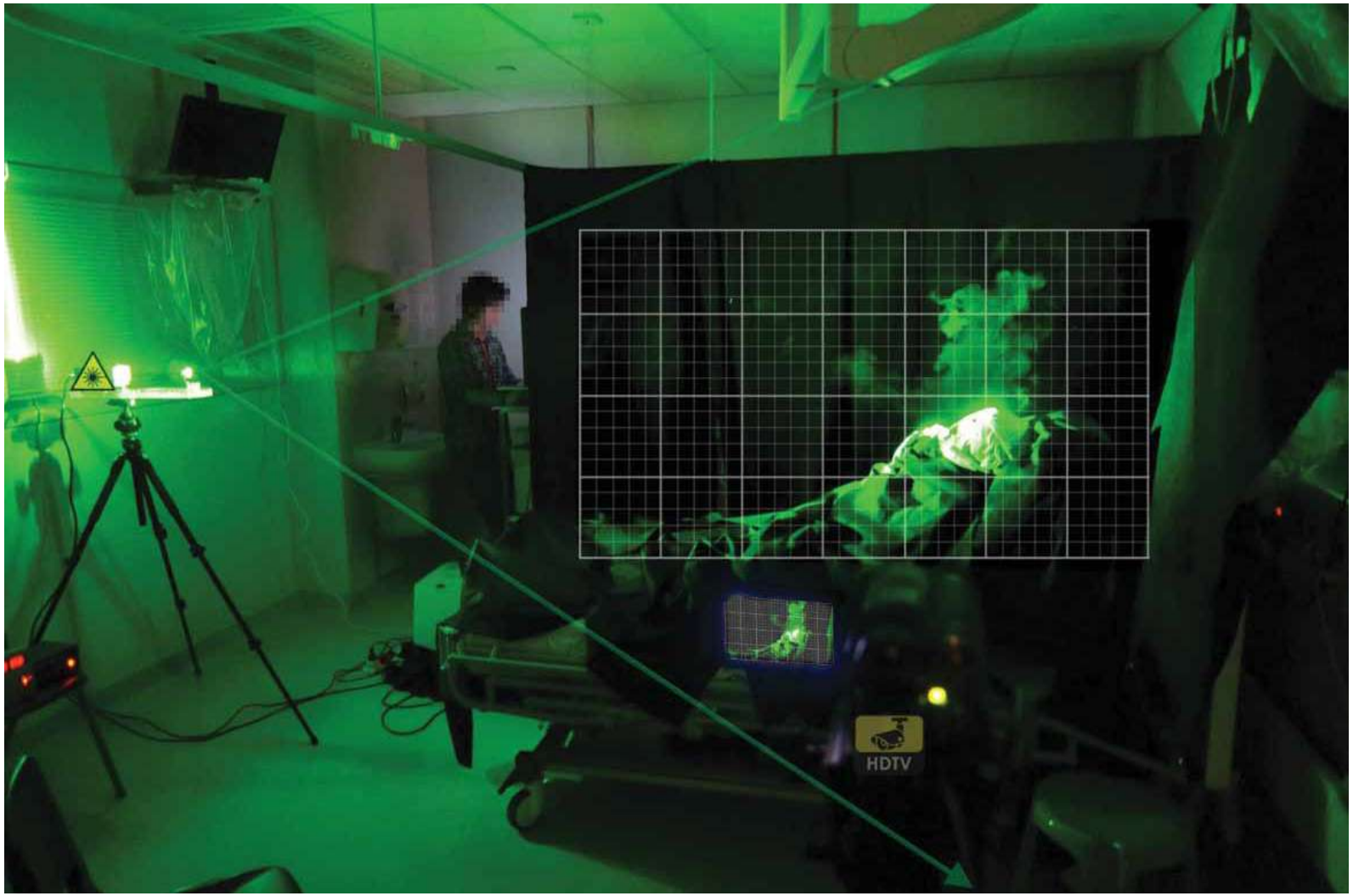
ERS/ATS guidelines 2017

Absolute indications

- ❑ **Hypercapnic RF**
  - ➢ COPD
  - ➢ Bronchiectasis
  - ➢ Restrictive diseases
    - ▪ Obesity Hypoventilation Syndrome
    - ▪ Thoracic abnormalities (eg kyphoscoliosis)
    - ▪ Neuromuscular disease
- ❑ **Cardiogenic pulmonary oedema**
- ❑ **Others:**
  - ➢ post-operation RF (abdomen, chest, cardio)
  - ➢ Chest trauma
  - ➢ palliation

Αλλάζει κάτι λόγω πανδημίας?

high fidelity human mannequin model



Maximum exhaled air dispersion distance via different oxygen administration and ventilatory support strategies

Oxygen device	Flow rate L·min^{-1}	Dispersion distance cm
HFNC	60	17.2±3.3
	30	13.0±1.1
	10	6.5±1.5
Simple mask	15	11.2±0.7
	10	9.5±0.6
Non-rebreathing mask	10	24.6±2.2
Venturi mask at F_{IO_2} 0.4	6	39.7±1.6
Venturi mask at F_{IO_2} 0.35	6	27.2±1.1

Li J et al, ERJ 2020; 55: 2000892

Maximum exhaled air dispersion distance via different oxygen administration and ventilatory support strategies

Method	Maximum exhaled air dispersion distance
Oxygen *via* nasal cannula 5 L·min^{-1}	100 cm
Oxygen *via* oronasal mask 4 L·min^{-1}	40 cm
Oxygen *via* Venturi mask F_{IO_2} 40%	33 cm
Oxygen *via* non-rebreathing mask 12 L·min^{-1}	<10 cm
CPAP *via* oronasal mask 20 cmH_2O	Negligible air dispersion
CPAP *via* nasal pillows	33 cm
HFNC 60 L·min^{-1}	17 cm (62 cm sideways leakage if not tightly fixed)
NIV *via* full face mask: IPAP 18 cmH_2O, EPAP 5 cmH_2O	92 cm
NIV *via* helmet without tight air cushion: IPAP 20 cmH_2O, EPAP 10 cmH_2O	27 cm
NIV *via* helmet with tight air cushion: IPAP 20 cmH_2O, EPAP 10 cmH_2O	Negligible air dispersion

Ferioli M et al Eur Respir Rev 2020; 29: 200068

GERMAN Guidelines Application of Respiratory Support in Patients with COVID-19

- Based on current knowledge, **inhalation therapy, NHF, CPAP, or NIV** can be **carried out by staff wearing PPE** (goggles, an FFP2 or FFP3 mask, and a gown) **without an increased risk of infection**

- **The protection of staff with PPE should have top priority.**
- **Fear of contagion should not be a primary reason for intubation**

- **NHF :** To date, **a relevant increased release of infectious aerosols compared to spontaneously breathing patients could not be demonstrated in an in vitro or an in vivo setting.**

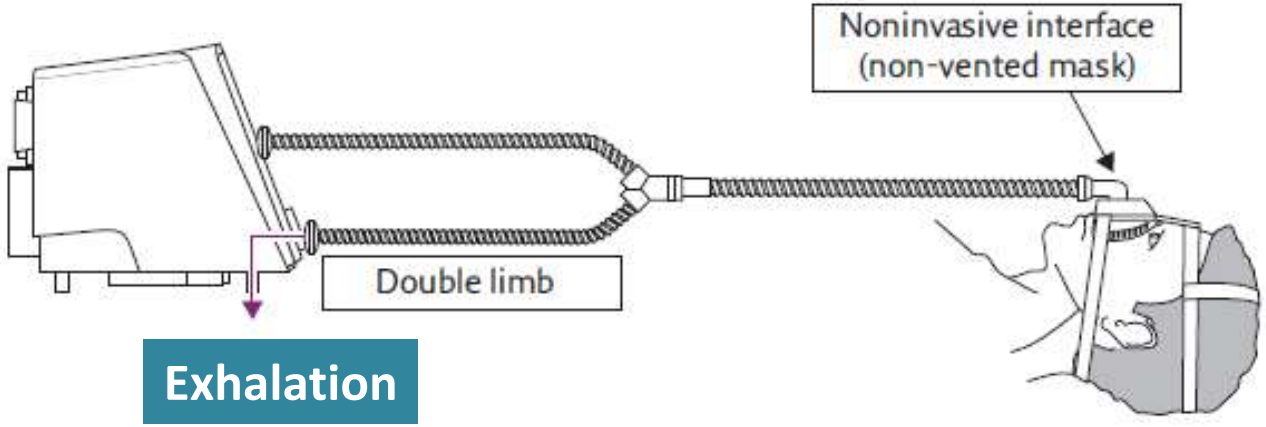
- Although **nebulizers** increase the amount of aerosol in room air, **they do not increase the risk of infection for medical staff**. The **inhalation of isotonic saline solution significantly reduces aerosol release from the lungs**.

HOW TO APPLY NIV IN THE PANDEMIC ERA

- **Nonvented masks should be used as interfaces**
  - oronasal, full-face masks, or respiratory helmets.
- **leakages should be reduced to a minimum**
- **dual-hose systems with virus deactivation filters in the expiratory tube** should preferably be used
- **When using single-hose systems**, **a virus filter should be inserted between the interface and the intended leakage (whisper swivel) or the exhalation valve**
- **When using a patient's own device:** patients with previous CPAP or NIV **require an appropriate mask and tube change, including the insertion of a virus filter**
- A **virus deactivation filter** should be inserted between the interface and the expiration device (intended leakage or expiration valve for single-hose systems).

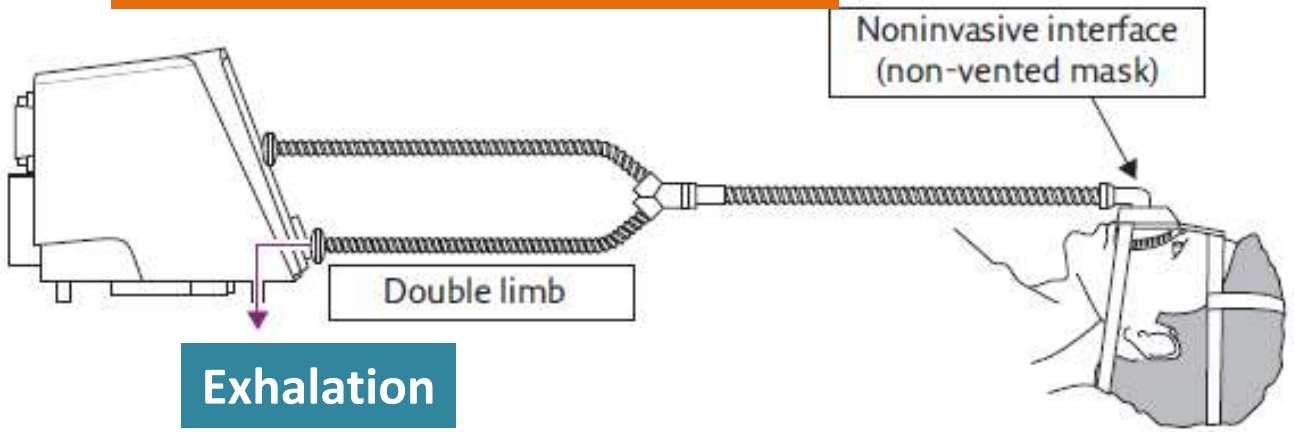
Non vented mask

Double Limb-Non vented mask

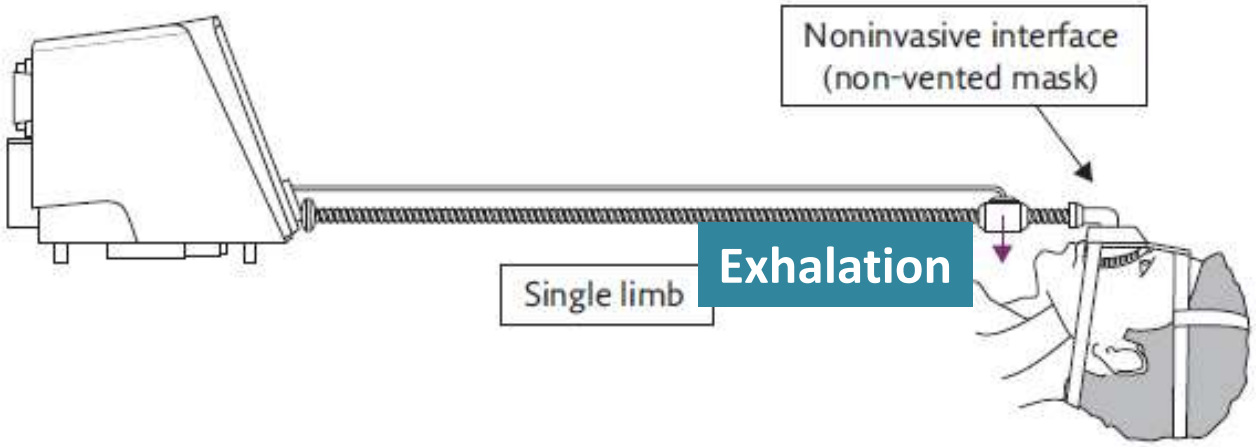


HOW TO APPLY NIV IN THE PANDEMIC ERA

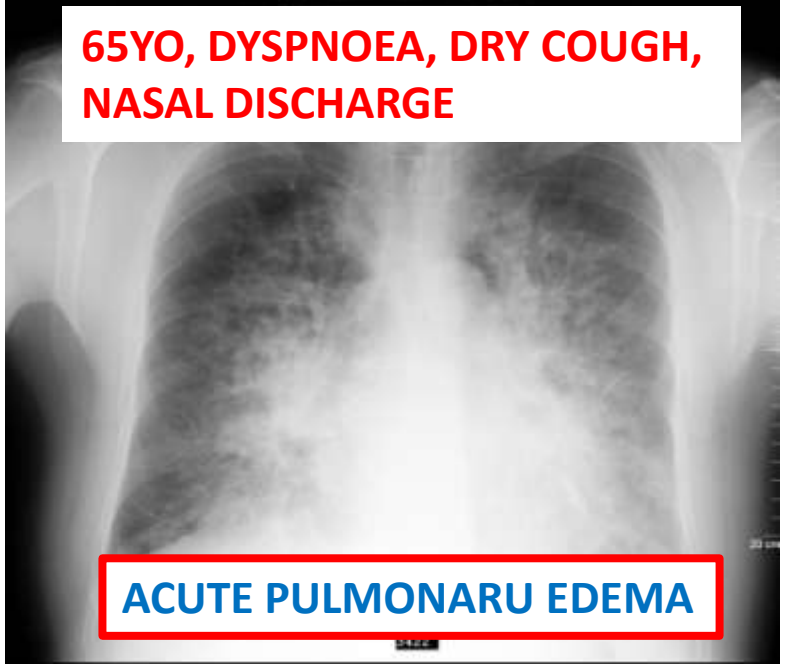
Double Limb-Non vented mask



Single Limb - Non vented mask

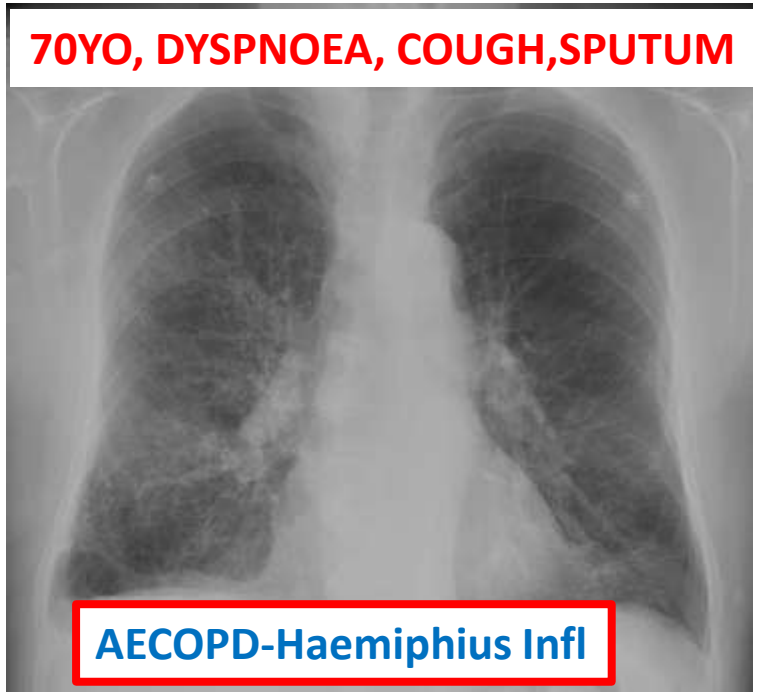


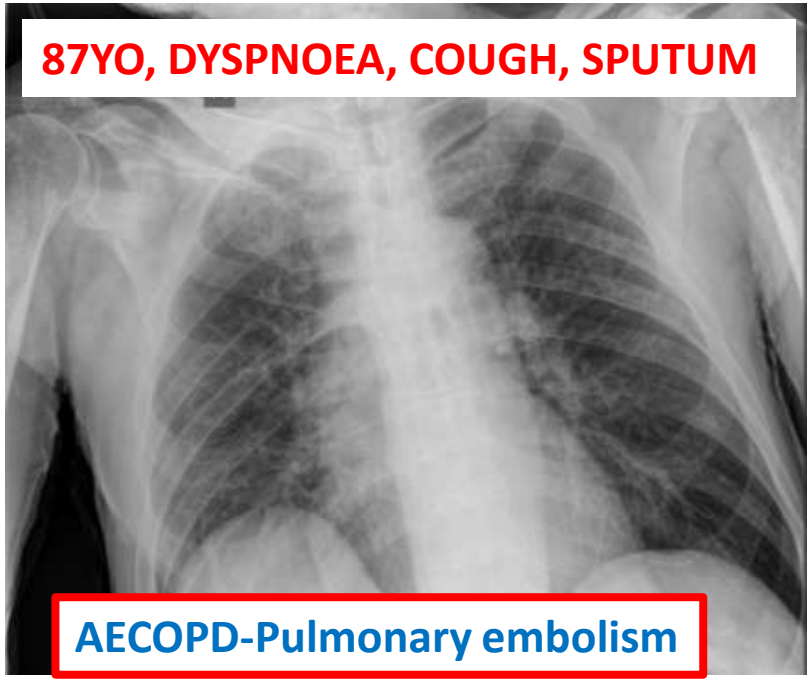
Hypoxemix RF



CPAP or NIV

Hypercapnic RF





Nebs SAMA/SABA
If
hypercapnia+acidosis
persists → NIV

- What if they deteriorate and require emergency intubation

- Endotracheal intubation carries a high risk of infection.

ENDOTRACHEAL INTUBATION

WHO- Management of critical COVID-19: ARDS

We recommend that endotracheal intubation be performed by a trained and experienced provider using airborne precautions.

- **Pre-oxygenation with 100% FiO2 for 5 minutes, and use of a face mask with reservoir bag is preferred**.
- When possible, **avoid bag-valve mask ventilation** to reduce exposure to aerosols.
- **Rapid-sequence intubation** is appropriate after an airway assessment that identifies no signs of difficult intubation

Surviving Sepsis Campaign: Guidelines on the Management of Critically Ill Adults with Coronavirus Disease 2019

- For healthcare workers performing **endotracheal intubation** on patients with COVID-19, **we suggest using video-guided laryngoscopy, over direct laryngoscopy, if available**. **Weak**
- For COVID-19 patients requiring **endotracheal intubation**, **we recommend** that **endotracheal intubation be performed by the healthcare worker who is most experienced with airway management in order to minimize the number of attempts and risk of transmission**. **Best practice**

ESA European Society Of Anaesthesiology

AIRWAY MANAGEMENT

COVID-19

TEAM PREPARATION

▶**Minimize the number of team members:**

1. The most expert team member should perform the intubation and advanced airway control/ventilation (with donned PPE) [INSIDE the chamber]
2. EXPERT assistant on protocols and devices (doctor/nurse with donned PPE) [INSIDE the chamber]
3. Second doctor with donned PPE if complex maneuver/difficult airway is expected/planned [INSIDE the chamber]
4. Doctor available with donned PPE [OUTSIDE the chamber]
5. PPE donning/doffing Observer [OUTSIDE]

CARRY OUT PRELIMINARY BRIEFING FOR ROLE DEFINITION, STRATEGY DEFINITION, IDENTIFICATION OF DONNING/DOFFING OBSERVER

AIRWAY INSTRUMENTATION

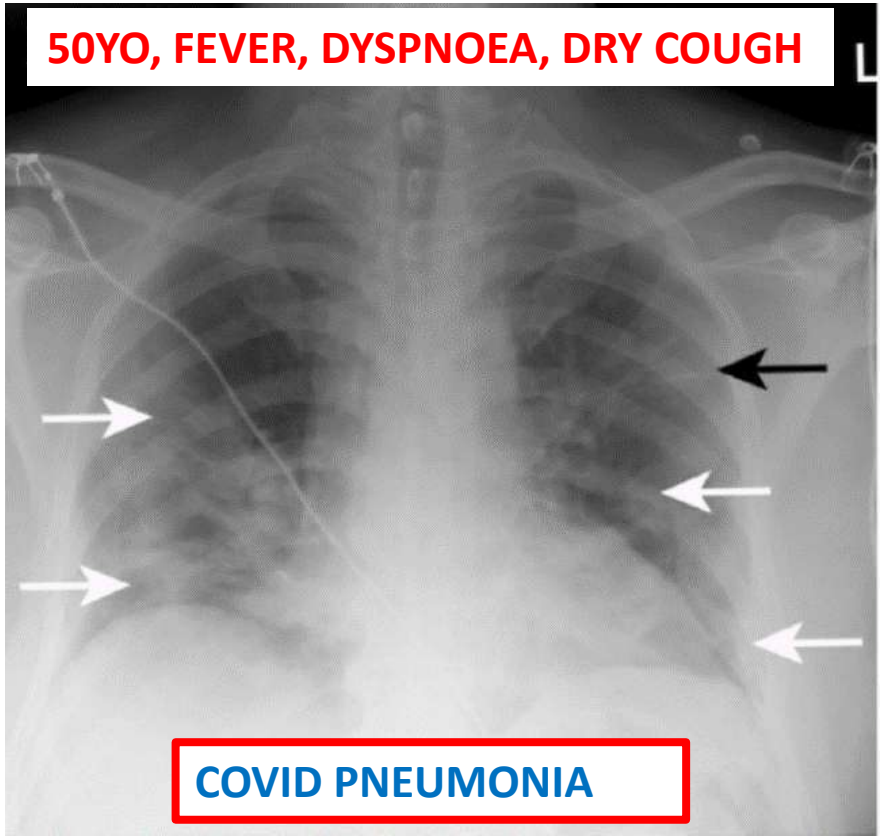
- ▶ HME FILTER ON EVERY OXYGENATION INTERFACE (face mask, circuit, endotracheal tube, supraglottic airway devices, introducer, airway exchange catheters)
- ▶ AIRWAY CART READY (DISPOSABLE devices preferable)
- ▶ SUCTION: CLOSED SYSTEM
- ▶ ANTIFOGGING
- ▶ MEDICATIONS: PREPARED AND DOUBLE-CHECKED
- ▶ EMERGENCY CART READY (DISPOSABLE devices preferable)

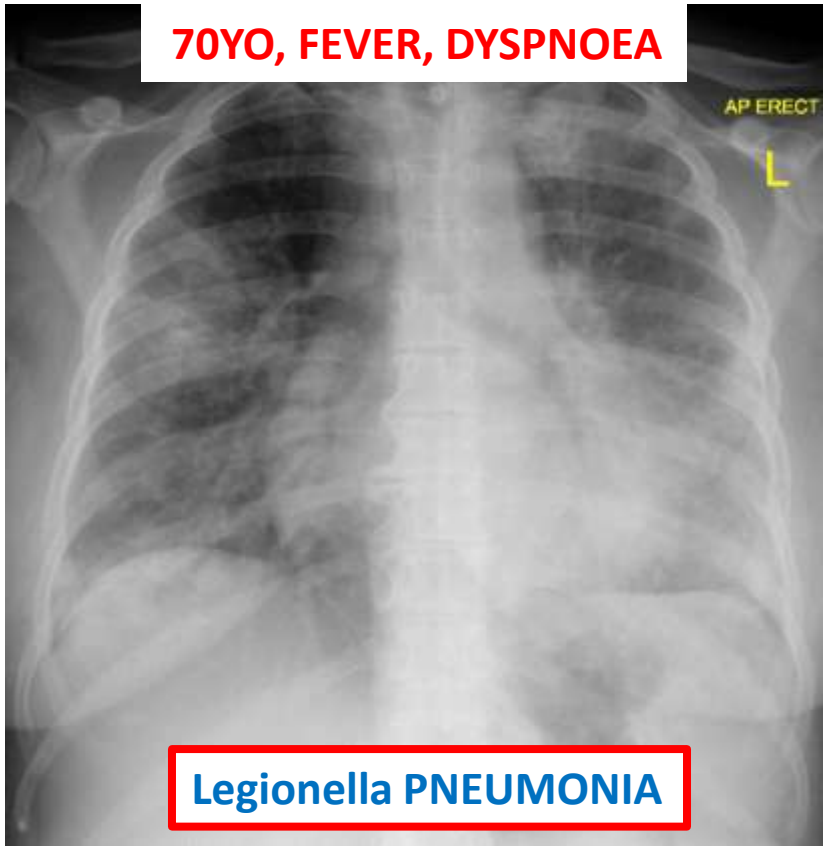
AWAKE INTUBATION NOT INDICATED:

- ▶ **PREOXYGENATION**
  (according to respiratory and hemodynamic status)
  - 3min' at TV FiO_2=100%
    or 1min' at FVC 8 breaths FiO_2=100%
    or CPAP/PSV 10 cm H_2O + PEEP 5 cm H_2O FiO_2=100%
- ▶ **RSI** in all patients (limit BMV **unless** unavoidable and **apply** Cricoid Pressure only in case of ongoing regurgitation)
- ▶ NASAL PRONGS 3 LT/MIN FIO2=100% FOR APNOIC PHASE **(NODESAT)**
- ▶ **FULL DOSE NEUROMUSCULAR BLOCK**
  RESPECT onset time for laryngoscopy
  - > 1st LARYNGOSCOPY:
    prefer **VIDEOLARYNGOSCOPE with separate screen + endotracheal tube pre-loaded on introducer**

    Re-oxygenate with low TV/pressure between attempts -Early switch (after failed second attempt) to supraglottic airway devices **(prefer second generation - intubable SADs)**
  - > INTUBATION THROUGH SUPRAGLOTTIC AIRWAY DEVICES:
    flexible endoscope with **separate screen** (prefer **DISPOSABLE**)
- ▶ **EARLY CRICOTHYROTOMY IF CI-CO**

De novo Hypoxemic Respiratory Failure





Surviving Sepsis Campaign: Guidelines on the Management of Critically Ill Adults with Coronavirus Disease 2019

Crit Care Med 2020; 48:e440–e469

Ventilation:

- ❑ In **adults with COVID-19**, we **suggest starting supplemental oxygen** if the peripheral Spo2 < 92%, Weak
  - and **recommend starting supplemental oxygen if Spo2 is < 90%** Strong
- ❑ In **adults with COVID-19 and acute hypoxemic respiratory failure on oxygen**, **we recommend** that **Spo2 be maintained no higher than 96%.** Strong
- ❑ For **adults with COVID-19 and acute hypoxemic respiratory failure** despite conventional oxygen therapy, **we suggest using HFNC over conventional oxygen therapy**. Weak

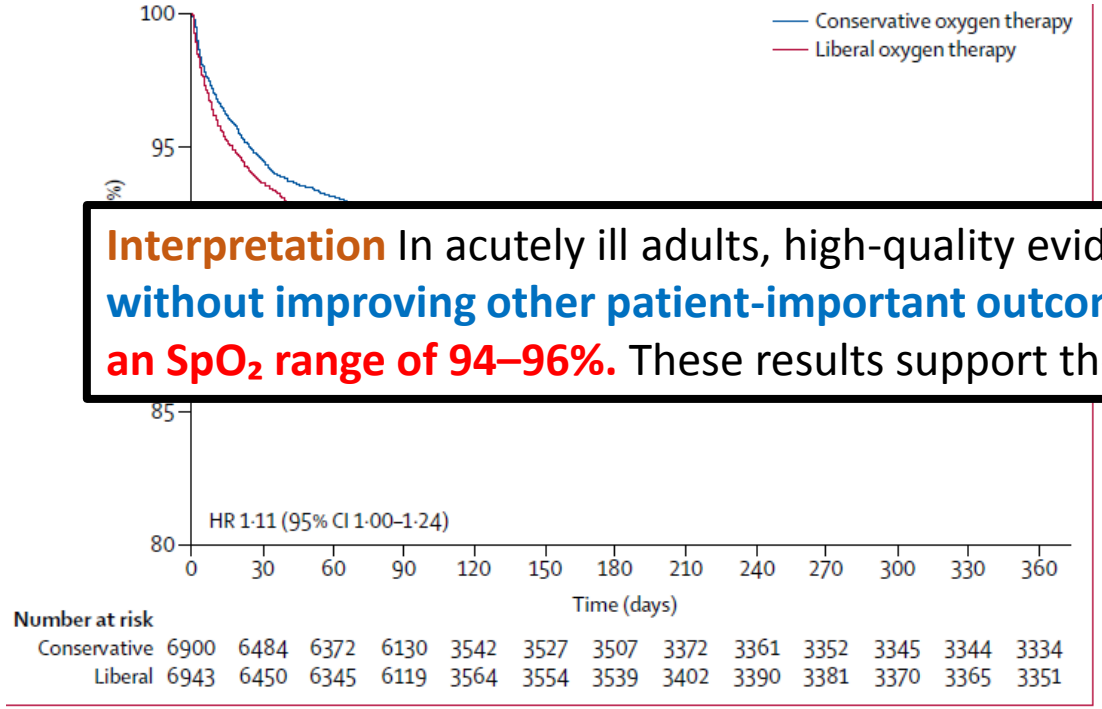
WHO- Management of severe COVID-19: severe pneumonia

- ❑ **We recommend immediate administration of supplemental oxygen therapy to any patient with emergency signs and to any patient without emergency signs and SpO2 < 90%.**
- ➢ **Adults with emergency signs : during resuscitation target SpO2 ≥ 94%.**
- ➢ **Once the patient is stable: target**
  - **> 90% SpO2 in non-pregnant adults**
  - **≥ 92–95% in pregnant women**

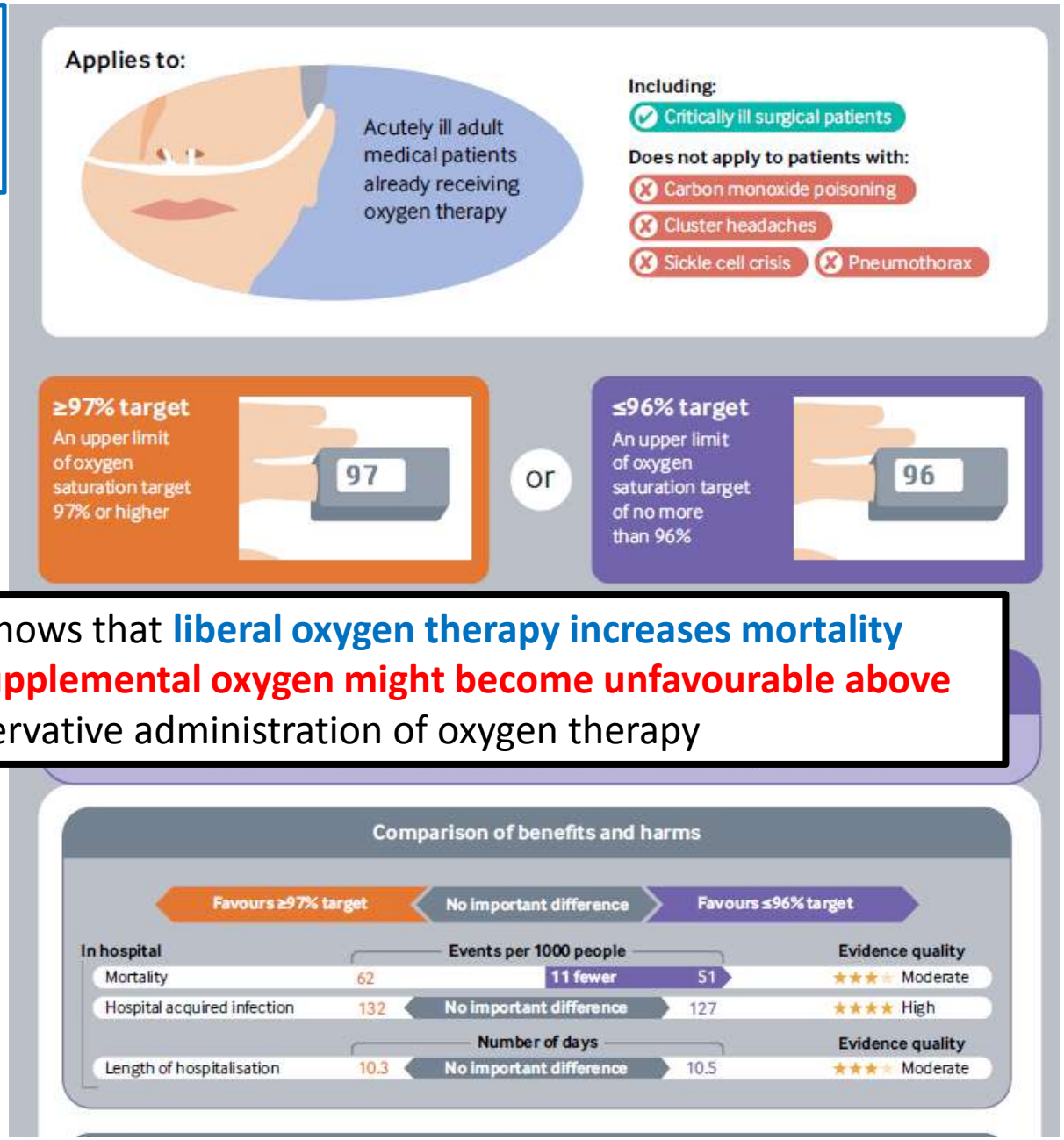
Mortality and morbidity in acutely ill adults treated with liberal versus conservative oxygen therapy (IOTA): a systematic review and meta-analysis

Chu D et al Lancet 2018; 391: 1693–705

cumulative survival
liberal versus conservative oxygen therapy



Interpretation In acutely ill adults, high-quality evidence shows that **liberal oxygen therapy increases mortality without improving other patient-important outcomes**. **Supplemental oxygen might become unfavourable above an SpO_2 range of 94–96%.** These results support the conservative administration of oxygen therapy



Siemieniuk R et al BMJ 2018;363:k4169

WHO- Management of severe COVID-19: severe pneumonia

- **Closely monitor patients for signs of clinical deterioration, such as**
  - **rapidly progressive respiratory failure**
    and
  - **shock**

  respond immediately with supportive care interventions

- Patients hospitalized with COVID-19 **require regular monitoring of vital signs (including pulse oximetry)** and, where possible, **utilization of medical early warning scores (e.g. NEWS2, PEWS)** that facilitate early recognition and escalation of treatment of the deteriorating patient

NEWS2 scores for escalating care- early warning score for monitoring hospital patients

National Early Warning Score (NEWS):
Royal College of Physicians in 2012
to improve the identification, monitoring and management of unwell patients in hospital.
Up-dated in 2017

National Early Warning Score -NEWS

Physiological parameter	Score 3	2	1	0	1	2	3
Respiration rate (per minute)	≤8		9–11	12–20		21–24	≥25
SpO_2 Scale 1 (%)	≤91	92–93	94–95	≥96			
SpO_2 Scale 2 (%)	≤83	84–85	86–87	88–92 ≥93 on air	93–94 on oxygen	95–96 on oxygen	≥97 on oxygen
Air or oxygen?		Oxygen		Air			
Systolic blood pressure (mmHg)	≤90	91–100	101–110	111–219			≥220
Pulse (per minute)	≤40		41–50	51–90	91–110	111–130	≥131
Consciousness				Alert			CVPU
Temperature (°C)	≤35.0		35.1–36.0	36.1–38.0	38.1–39.0	≥39.1	

Chart 2: NEWS thresholds and triggers

NEW score	Clinical risk	Response
Aggregate score 0–4	Low	Ward-based response
Red score Score of 3 in any individual parameter	Low–medium	Urgent ward-based response*
Aggregate score 5–6	Medium	Key threshold for urgent response*
Aggregate score 7 or more	High	Urgent or emergency response**

* Response by a clinician or team with competence in the assessment and treatment of acutely ill patients and in recognising when the escalation of care to a critical care team is appropriate.

**The response team must also include staff with critical care skills, including airway management.

NEW score	Frequency of monitoring	Clinical response
0	Minimum 12 hourly	• Continue routine NEWS monitoring
Total 1–4	Minimum 4–6 hourly	• Inform registered nurse, who must assess the patient • Registered nurse decides whether increased frequency of monitoring and/or escalation of care is required
3 in single parameter	Minimum 1 hourly	• Registered nurse to inform medical team caring for the patient, who will review and decide whether escalation of care is necessary
Total 5 or more Urgent response threshold	Minimum 1 hourly	• Registered nurse to immediately inform the medical team caring for the patient • Registered nurse to request urgent assessment by a clinician or team with core competencies in the care of acutely ill patients • Provide clinical care in an environment with monitoring facilities
Total 7 or more Emergency response threshold	Continuous monitoring of vital signs	• Registered nurse to immediately inform the medical team caring for the patient – this should be at least at specialist registrar level • Emergency assessment by a team with critical care competencies, including practitioner(s) with advanced airway management skills • Consider transfer of care to a level 2 or 3 clinical care facility, ie higher-dependency unit or ICU • Clinical care in an environment with monitoring facilities

Modified NEWS score for use in COVID-19

developed in China-Liao

Early warning score for 2019-nCoV Infected Patients

PARAMETERS	3	2	1	0	1	2	3
Age				<65			≥65
Respiration Rate	≤8		9 - 11	12 - 20		21 - 24	≥25
Oxygen Saturations	≤91	92 - 93	94 - 95	≥96			
Any Supplemental Oxygen		Yes		No			
Systolic BP	≤90	91 - 100	101 - 110	111 - 219			≥220
Heart Rate	≤40		41 - 50	51 - 90	91 - 110	111 - 130	≥131
Consciousness				Alert			Drowsiness Letargy Coma Confusion
Temperature	≤35.0		35.1 - 36.0	36.1 - 38.0	38.1 - 39.0	≥39.1	

Early warning rules for 2019-nCoV Infected Patients

Score	Risk Grading	Warning Level	Monitoring Frequency	Clinical Response	Solution
0	/		Q12h	Routine Monitoring	/
1 - 4	Low	Yellow	Q6h	Bedside evaluation by nurse	Maintain existing monitoring/ Increase monitoring frequency/ Inform doctor
5 - 6 or 3 in one parameter	Medium	Orange	Q1-2h	Bedside nurse notifies doctor for evaluation	Maintain existing treatment/ Adjust treatment plan/ CCRRT* remote consultation
≥7	High	Red	Continuous	Bedside nurse notifies doctor for emergency bedside evaluation/ CCRRT remote consultation	CCRRT on-site consultation
≥7	High	Black	Continuous	✓ Patients are extremely severe with irreversible end-stage diseases facing death, such as serious irreversible brain injury, irreversible multiple organ failure, end-stage chronic liver or lung disease, metastatic tumors, etc. ✓ Should be discussed urgently by the expert group about the admission decision.	

Fig. 1 Early warning score and rules for 2019-nCoV infected patients. *CCRRT: Critical Care Rapid Response Team

WHAT IS THE NEXT STEP

A

B

C

D

EVIDENCE
BEFORE PANDEMIC

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

Eur Respir J 2017; 50 (2): 1602426

Should NIV be used in *de novo* ARF?

Recommendation

- **Given the uncertainty of evidence we are unable to offer a recommendation on the use of NIV for *de novo* ARF**

Further research is needed and **this question requires re-appraisal in the future**. Considering that some studies have identified populations likely to succeed with NIV, **a trial of NIV might be offered to a patient with hypoxaemic respiratory failure, community-acquired pneumonia or early ARDS if they are being managed by an experienced clinical team, are carefully selected** (no contraindications such as abnormal mental status, shock or multiorgan system failure), **are closely monitored in the ICU**, **reassessed early after starting NIV and intubated promptly if they are not improving.**

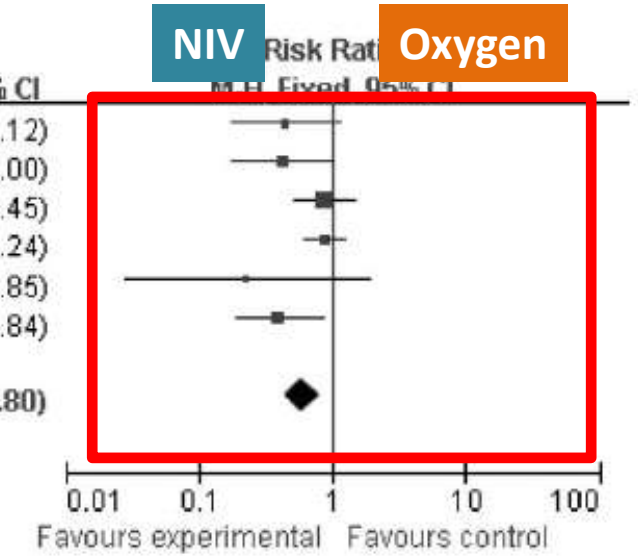
Endotracheal intubation rate

Study or Subgroup	NIPPV Events	Total	Standard Oxygen Therapy Events	Total	Weight	Risk Ratio M-H, Fixed, 95% CI
Antonelli et al. 2000[20]	3	8	6	7	10.6%	0.44 (0.17–1.12)
Auriant et al. 2001[22]	5	24	12	24	19.9%	0.42 (0.17–1.00)
Delclaux et al. 2000[21]	15	40	18	41	29.5%	0.85 (0.50–1.45)
Ferrer et al. 2003[23]	6	7	8	8	13.3%	0.86 (0.60–1.24)
Zhan et al. 2012[24]	1	21	4	19	7.0%	0.23 (0.03–1.85)
Zhi et al. 2012[25]						(0.19–0.84)
Total (95% CI)						**(0.44–0.80)**
Total events	35		59			

Heterogeneity: $X^2 = 8.82$, df = 5 ($P = 0.12$); $I^2 = 43\%$

Test for overall effect: $z = 3.44$ ($P = 0.0006$)

Average NIV failure rate ≈50%

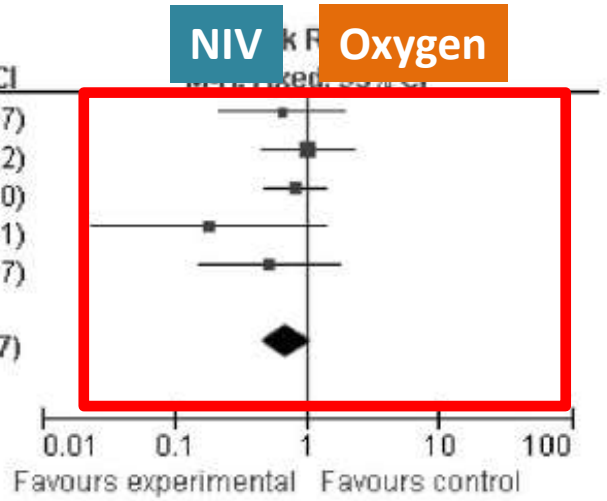


ICU mortality rate

Study or Subgroup	NIPPV Events	Total	Standard Oxygen Therapy Events	Total	Weight	Risk Ratio M-H, Fixed, 95% CI
Antonelli et al. 2000[20]	3	8	4	7	14.1%	0.66 (0.22–1.97)
Delclaux et al. 2000[21]	9	40	9	41	29.3%	1.02 (0.45–2.32)
Ferrer et al. 2003[23]	5	7	7	8	21.6%	0.82 (0.48–1.40)
Zhan et al. 2012[24]	1	21	5	19	17.3%	0.18 (0.02–1.41)
Zhi et al. 2012[25]	3	15	5	13	17.7%	0.52 (0.15–1.77)
Total (95% CI)		**91**		**88**	**100.0%**	**0.69 (0.45–1.07)**
Total events	21		30			

Heterogeneity: $X^2 = 3.11$, df = 4 ($P = 0.54$); $I^2 = 0\%$

Test for overall effect: $z = 1.65$ ($P = 0.10$)

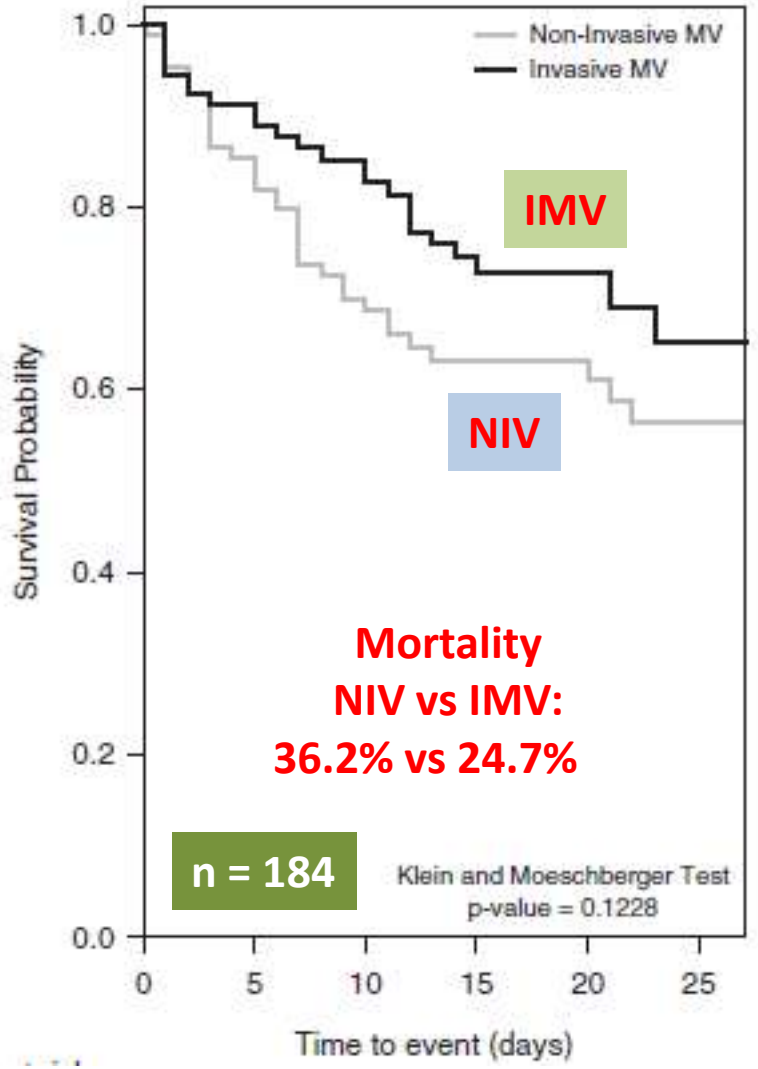


Luo J et al. Respirology (2014) 19, 1149–1157

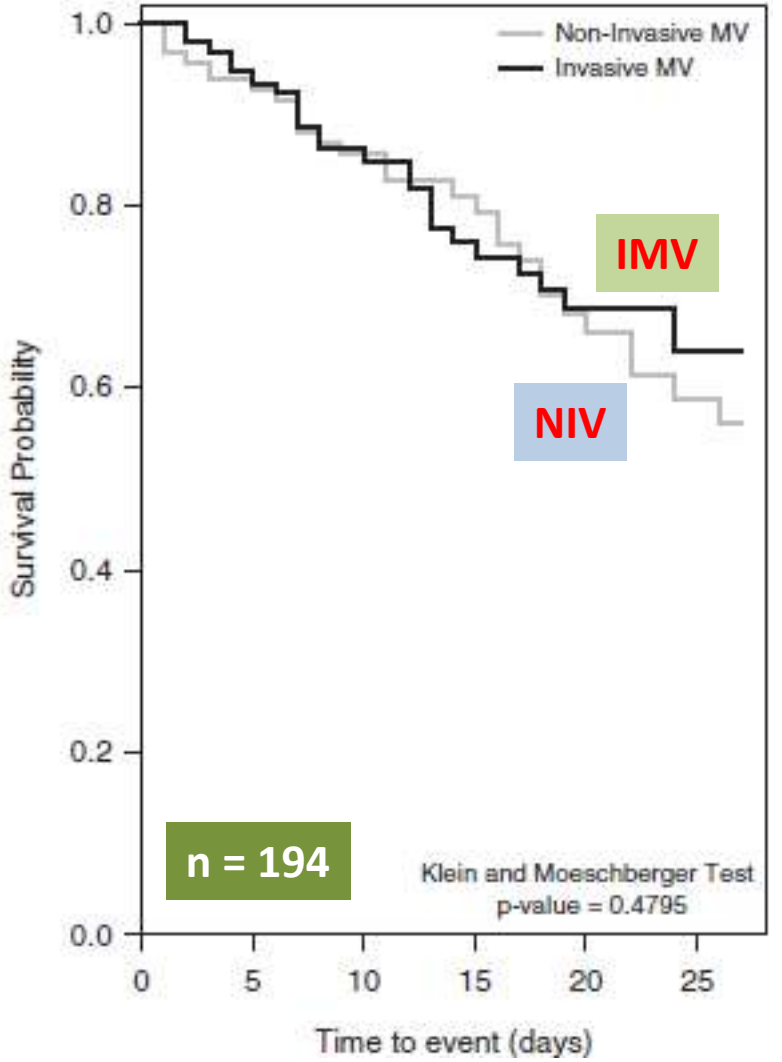
LUNG SAFE Study

Kaplan-Meier survival curves

PaO2/FIO2 <150 mmHg



PaO2/FIO2 ≥150 mmHg



Bellani G et al. AJRCCM 2017;195(1):67–77

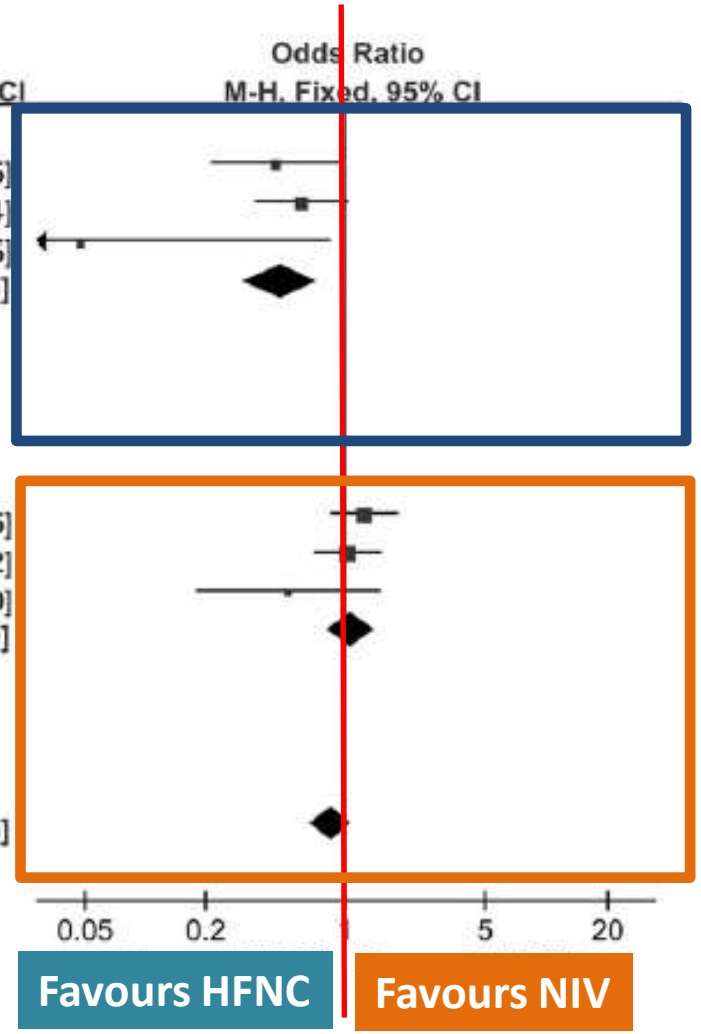
NIV vs HFNO

intubation rates

PaO2/FiO2 (150mmHg)

PaO2/FiO2 (200mmHg)

	HFNC		NIPPV			Odds Ratio
	Events	Total	Events	Total	Weight	M-H, Fixed, 95% CI
Coudroy 2016	21	60	30	55	12.3%	0.45 [0.21, 0.95]
Frat 2015	40	106	55	110	20.2%	0.61 [0.35, 1.04]
Nagata 2015	0	33	10	43	5.4%	0.05 [0.00, 0.85]
Subtotal (95% CI)		**199**		**208**	**37.9%**	**0.48 [0.31, 0.73]**
Total events	61		95			
Heterogeneity: Chi² = 3.25, df = 2 (P = 0.20); I² = 38%						
Test for overall effect: Z = 3.44 (P = 0.0006)						
Hernández 2016	66	290	60	314	26.8%	1.25 [0.84, 1.85]
Stéphan 2016	58	414	57	416	29.5%	1.03 [0.69, 1.52]
Yoo 2016	7	34	13	39	5.8%	0.52 [0.18, 1.50]
Subtotal (95% CI)		**738**		**769**	**62.1%**	**1.07 [0.82, 1.40]**
Total events	131		130			
Heterogeneity: Chi² = 2.40, df = 2 (P = 0.30); I² = 17%						
Test for overall effect: Z = 0.52 (P = 0.60)						
Total (95% CI)		**937**		**977**	**100.0%**	**0.85 [0.68, 1.06]**
Total events	192		225			
Heterogeneity: Chi² = 13.51, df = 5 (P = 0.02); I² = 63%						
Test for overall effect: Z = 1.45 (P = 0.15)						
Test for subgroup differences: Chi² = 10.16, df = 1 (P = 0.001), I² = 90.2%						



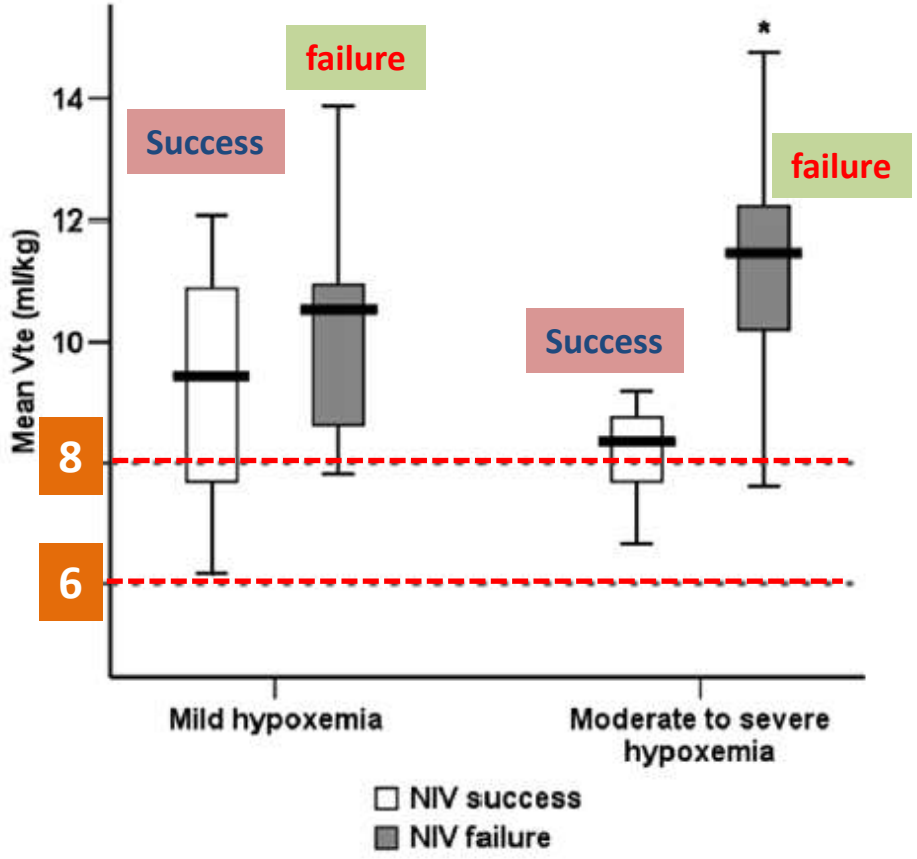
Shen and Zhang Critical Care (2017) 21:285

The role of expired Tidal Volume on NIV Failure

Expired TV ml/kg
over the whole duration of NIV

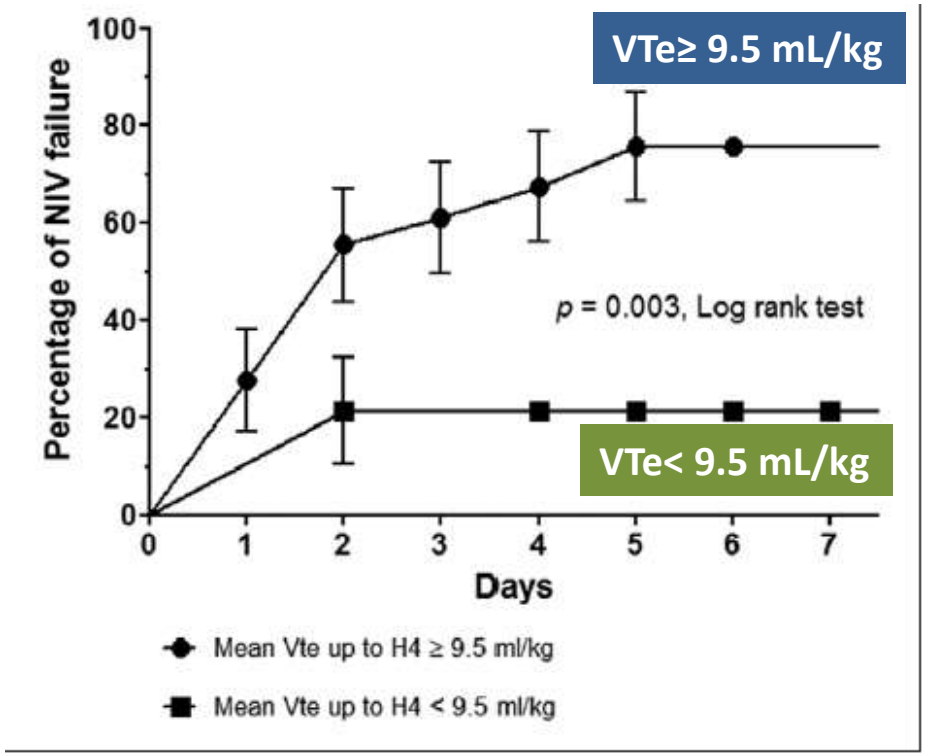
mild hypoxemia
200 < PaO2/FiO2 ≤ 300

Moderate to severe hypoxemia
PaO2/FiO2 ≤ 200 mm Hg



probability of NIV failure
mean TV over 4 Hours

Moderate to severe hypoxemia
PaO2/FiO2 ≤ 200 mm Hg



Carteaux Get al. Crit Care Med 2016; 44:282–290

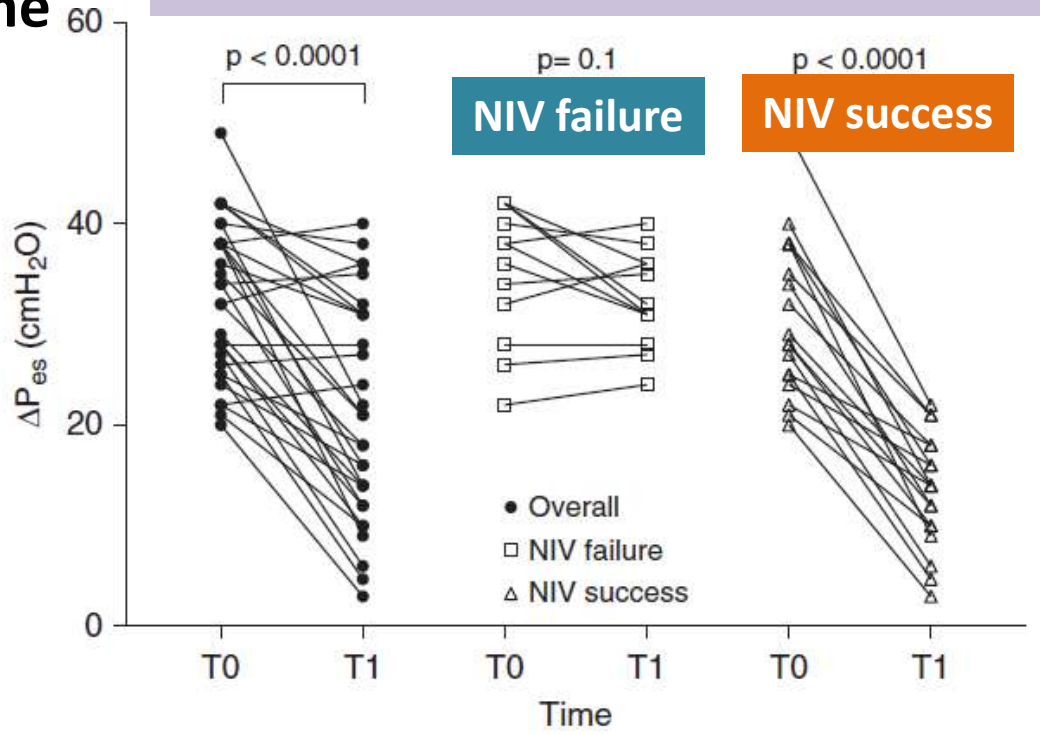
Early Inspiratory Effort Assessment by Esophageal Manometry Predicts Noninvasive Ventilation Outcome in De Novo Respiratory Failure A Pilot Study

Tonelli R et al AJRCCM 2020;202(4):558–567

- ICU ITALY
- 30 patients, AHRF, PaO2/FiO2<200
- 24h NIV trial

- **PEEP**- initially 6 cmH2O - modified to 4–8 cmH2O – target
  - **SaO2 >92%**
  - **with a FIO2 <70%.**
- **PS** set at 10 cm H2O - modified to target a
  - **VTe/kgPBW <9.5 ml/kg**
  - **RR <30 breaths/min**
- **oronasal facemask** -adjusted to target a **leak flow<20 L/min**

DPes changes from baseline within the first 2 hours of NIV



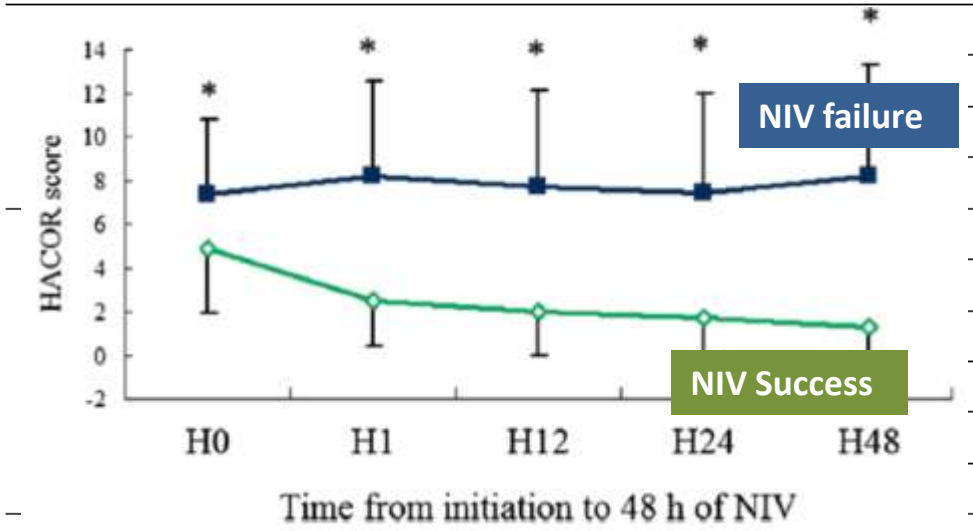
Association between Physiological and Clinical Variables and NIV Failure at 24 Hours

Feature	OR	95% CI	*P* Value
ΔPes < 10 cm H_2O post 2 h NIV	15	2.8–110	0.001
V_{TE} > 9.5 ml/kg of PBW	7.9	1.5–72	0.02
HACOR score >5 post 2 h NIV	6.3	0.9–49	0.046
RR > 30 bpm	5.5	0.8–112	0.14
$Pa_{O_2}/F_{I_{O_2}}$ ratio < 150 mm Hg	2	0.5–9.8	0.4
$V_{TE}/\Delta P_L$ ratio < 0.33 ml/kg/cm H_2O	2	0.4–9.8	0.36

prediction of NIV failure in de novo ARF

The HACOR score 0-25

Variable	Category	Assigned points
Heart rate, beats/min	≤120	0
	≥121	1
pH	≥7.35	0
	7.30–7.34	2
	7.25–7.29	3
	<7.25	4
Respiratory rate, breaths/min	≤30	0
	31–35	1
	36–40	2
	41–45	3
	≥46	4



cut-off value: 5 after 1 hour of NIV

SE (%)	SP (%)	PPV (%)	NPV (%)
73.9	91.4	87.1	81.6

HACOR score of ≤5,

- **NIV failure rate**:**18.4%**
- **Hospital mortality**: 21.6%.

HACOR score of >5,

- **NIV failure rate**:**87.1%**
- **Hospital mortality**: 65.2%.

Duan J et al. Int Care Med (2017) 43:192–199

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

ROX index
the ratio of SpO2 / FIO2 / respiratory rate

- **ROX Index ≥4.88** measured **at 2, 6, or 12 hours** after high-flow nasal cannula (HFNC) initiation is associated with **a lower risk for intubation**.
- **ROX Index <3.85 : risk of HFNC failure is high**, and **intubating the patient should be discussed.**
- **ROX Index 3.85 to <4.88: the scoring could be repeated one or two hours later for further evaluation.**

Roca O et al AJRCCM 2019; 199(11):1368–1376

COVID19 PANDEMIC PERIOD

ALGORITHM for the management of patients with acute hypoxaemic respiratory failure secondary to Coronavirus Disease 2019

COVID-19 with hypoxia

Indication for endotracheal intubation?

Yes

- **Do** Endotracheal intubation
- **Do** Expert in airway to intubate
- **Do** Use N-95/FFP-2 or equivalent and another PPC/infection control precautions
- **Do** Minimize staff in the room
- **Consider** *if available* Video-laryngoscope

No

Tolerating supplemental oxygen?

Yes

- **Do** Monitor closely for worsening
- **Do** Target SPO_2 92-96 %
- **Do** Appropriate infection control precautions
- **Do not** Delay intubation if worsening

No

Consider HFNC

Tolerating HFNC

Not tolerating HFNC or HFNC is not available

Indication for endotracheal intubation?

Yes

- **Do** Endotracheal intubation
- **Do** Expert in airway to intubate
- **Do** Use N-95/FFP-2 or equivalent and another PPC/infection control precautions
- **Do** Minimize staff in the room
- **Consider** *if available* Video-laryngoscope

No

- **Consider** A trial of NIPPV
- **Do** Monitor closely at short intervals
- **Do not** Delay intubation if worsening

Society of Critical Care Medicine
The Intensive Care Professionals

Surviving Sepsis Campaign

ESICM
The Intensive Care Society

Surviving Sepsis Campaign: Guidelines on the Management of Critically Ill Adults with Coronavirus Disease 2019

Crit Care Med 2020; 48:e440–e469

Ventilation:

- **In adults with COVID-19 and acute hypoxemic respiratory failure**
  - we **suggest using HFNC over NIPPV**. Weak
  - 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
- 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

WHO- Management of critical COVID-19: ARDS

In **selected patients with COVID-19 and mild ARDS**, a **trial of HFNO, NIV– CPAP, BiPAP may be used**.

Respiratory non-invasive therapies for COVID-19: recommendations from scientific societies

First option

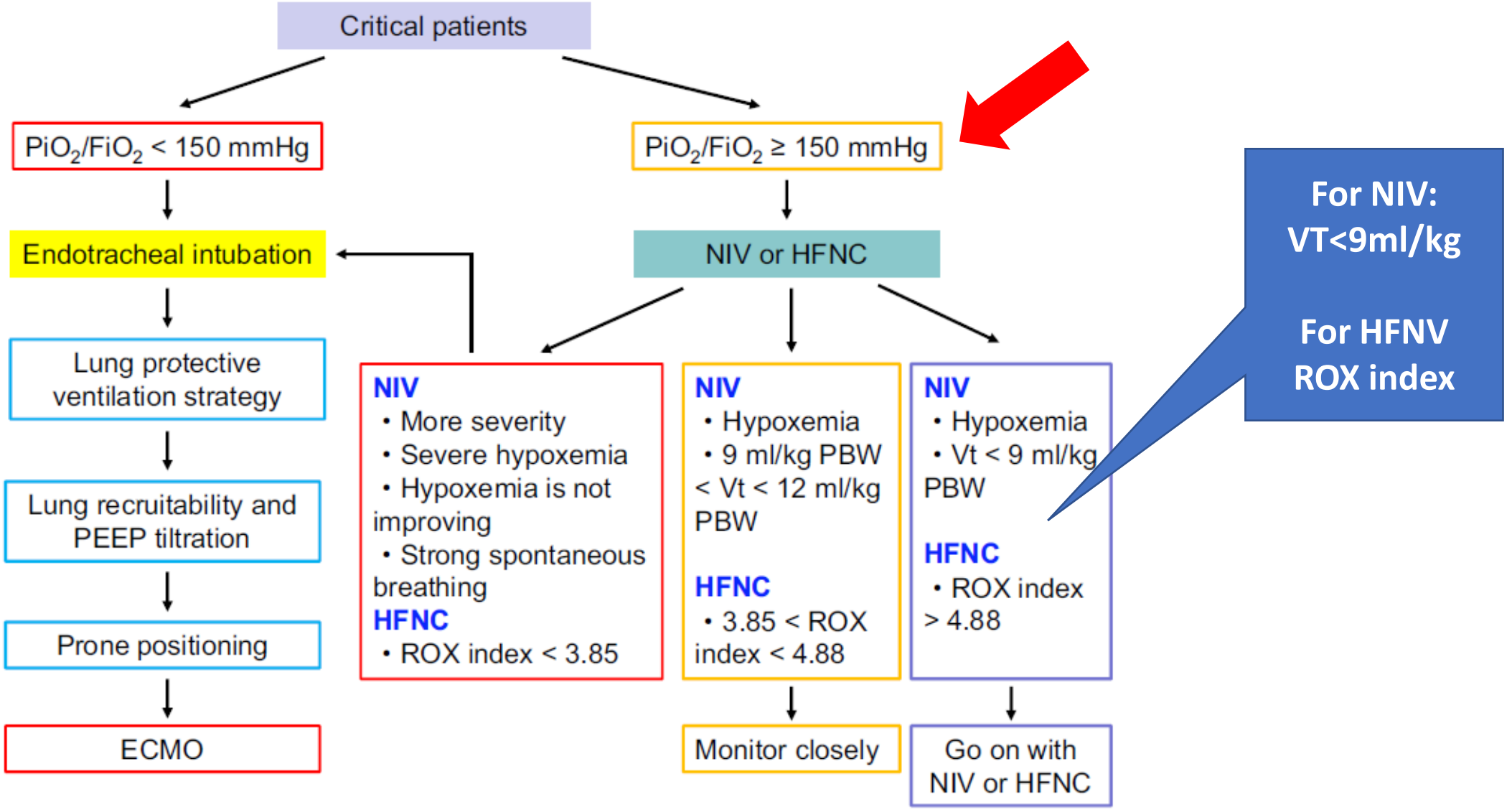
Scientific society (country), ref nr	Non-invasive respiratory therapy first option
SEPAR (Spain)[56]	HFNC
AIPO (Italy)[57]	Helmet CPAP
ESICM/SCCM (EU/US)[58]	HFNC
SPP (Portugal)[51]	HFNC or CPAP
NHS (UK)[59]	CPAP
WHO[60]	HFNC or NIV
CTS (China)[61]	HFNC
ANZICS (Australia/New Zealand)[62]	HFNC
Multiple Societies (Germany)[63]	Helmet NIV

Abbreviations: SEPAR-Sociedad Española de Patologia Respiratória; AIPO-Associazone Italiana Pneumologi Ospedalieri; ESICM-European Society of Intensive Care Medicine; SCCM-Society of Critical Care Medicine SPP-Sociedade Portuguesa de Pneumologia; CTS-Chinese Thoracic Society, ANZICS-Australian and New Zealand Intensive Care Society.

Wink JC & Ambrosino N Pulmonol 2020;26(4):213-20

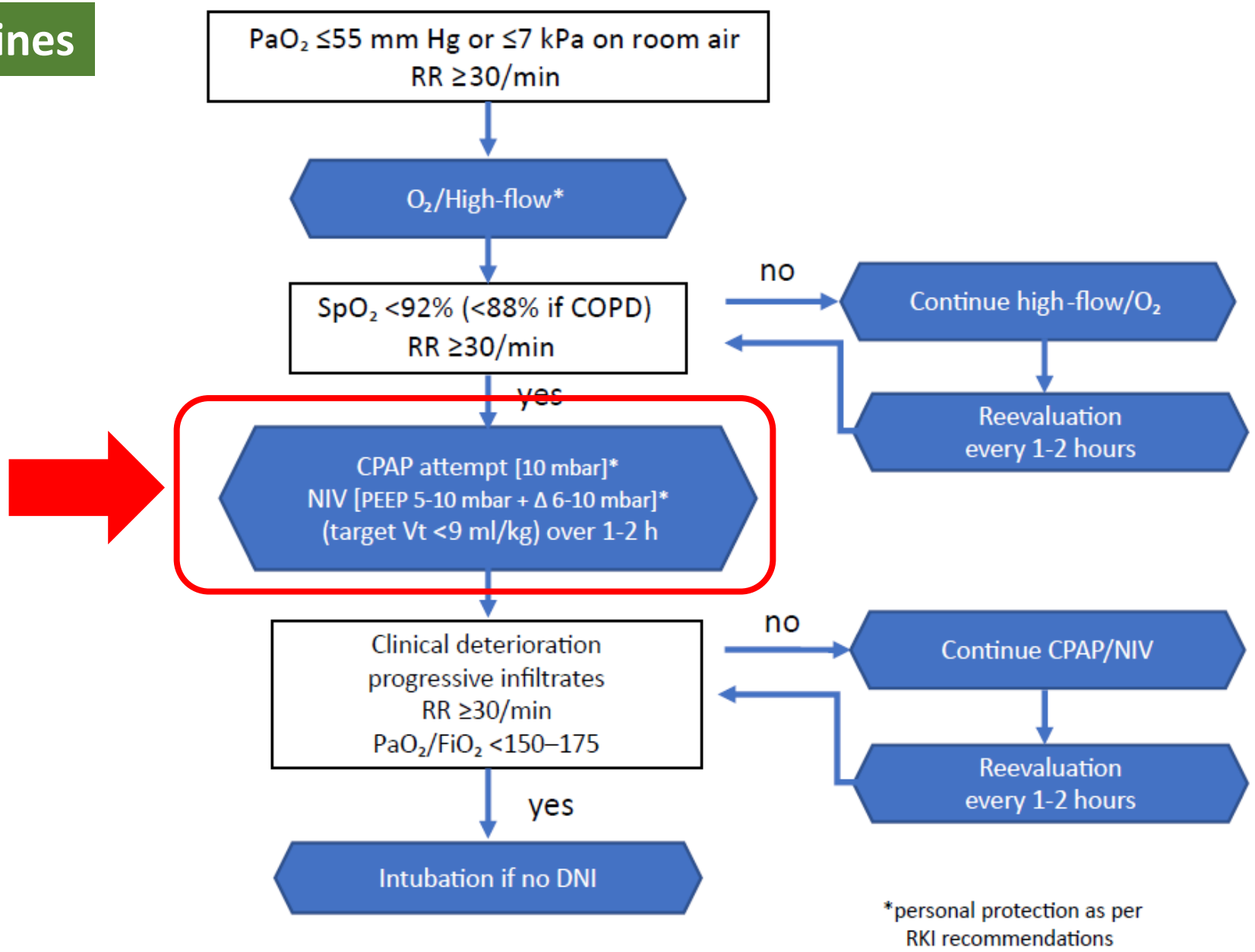
Management of critically ill patients with COVID-19 in ICU: statement from front-line intensive care experts in Wuhan, China

Shang et al. Ann. Intensive Care (2020) 10:73



Respiratory support options in COVID-19-related acute respiratory failure

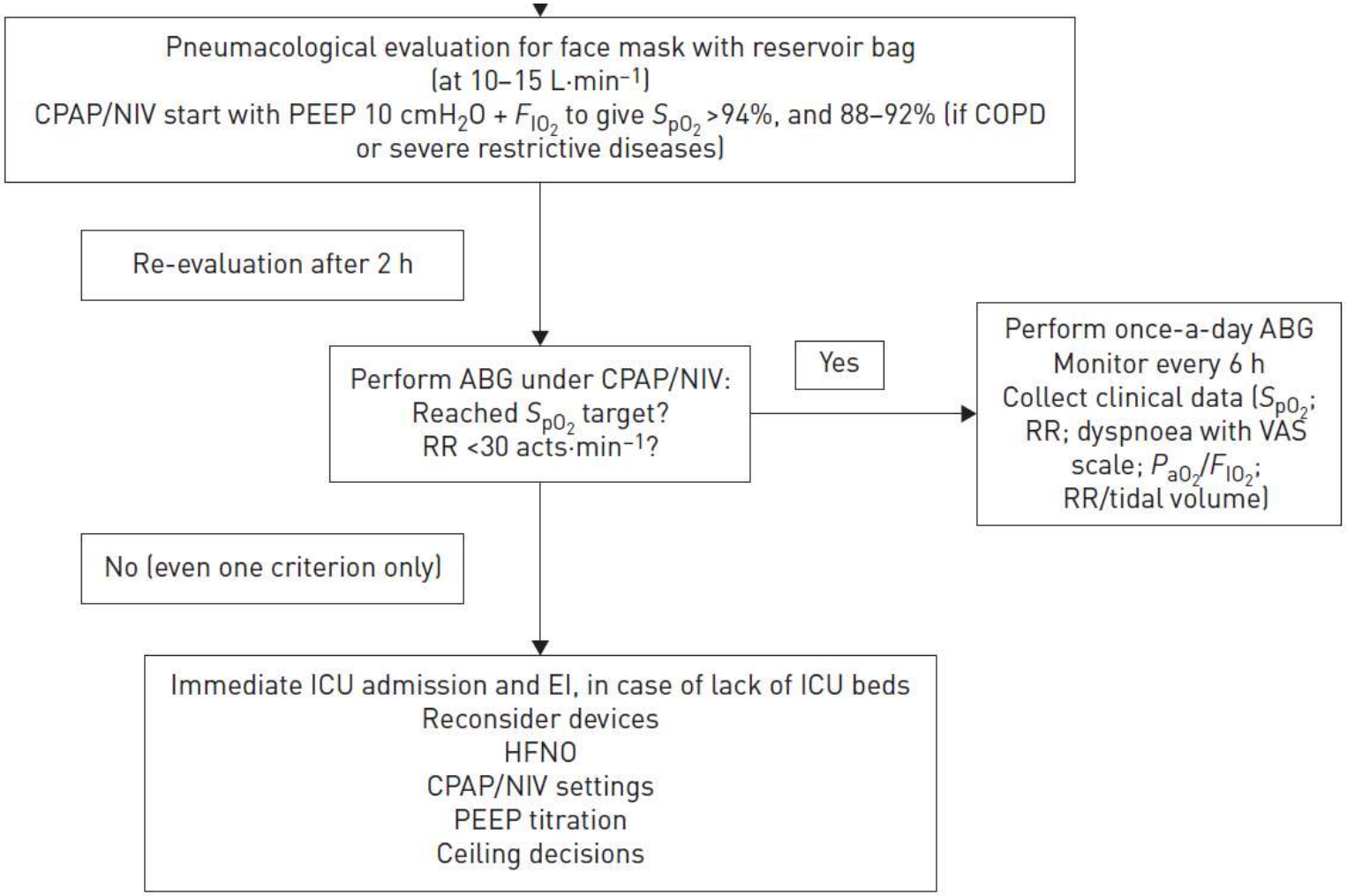
GERMAN Guidelines



ITALIAN GUIDELINES

the consensus set the indication for

- **CPAP :** use at **10–12 cmH2O**, **without humidification and with helmet** **first choice**
- **CPAP** use **with a mask** **second choice**
- **NIV** use with an **oronasal face mask** (**third choice**), using **high performance ventilators** or**, if these are lacking, dedicated NIV platforms or home ventilator**

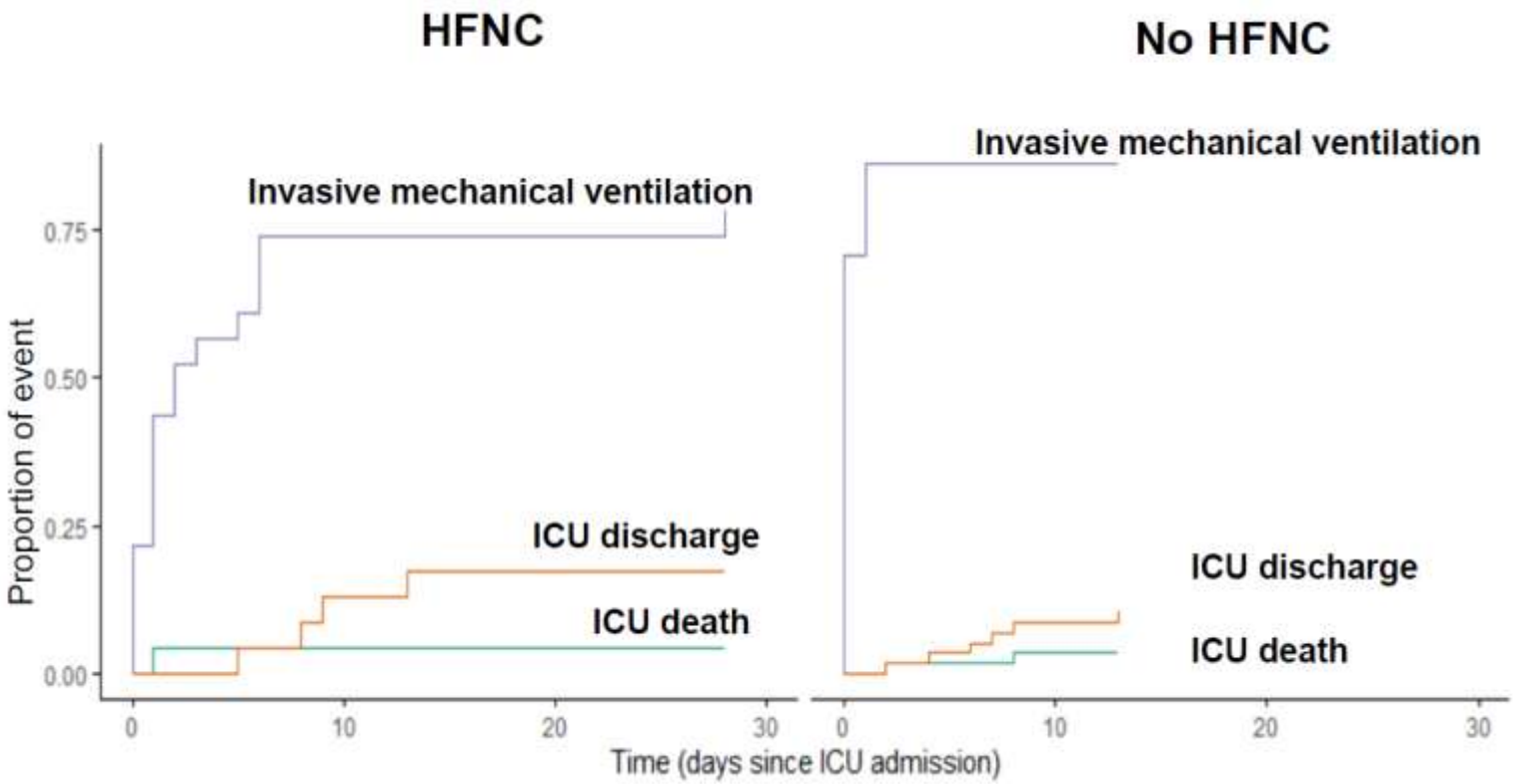


High Flow Nasal Canula in Critically Ill Severe COVID-19 Patients

Demoule A et al AJRCCM in press 10.1164/rccm.202005-2007LE

Retrospective study
379 patients, ICU Paris France
acute respiratory failure & laboratory-confirmed SARSCoV-2 infection
HFNC: 146 (39%) (within the first 24 hours of ICU admission) vs non –HFNO (mainly oxygen): 233

- **PaO_2/FiO_2**
  - HFNOs 126 (86-189) mmHg
  - non-HF 130 (97-195) mmHg
- **Median duration HFNO** 4 (2-6) D



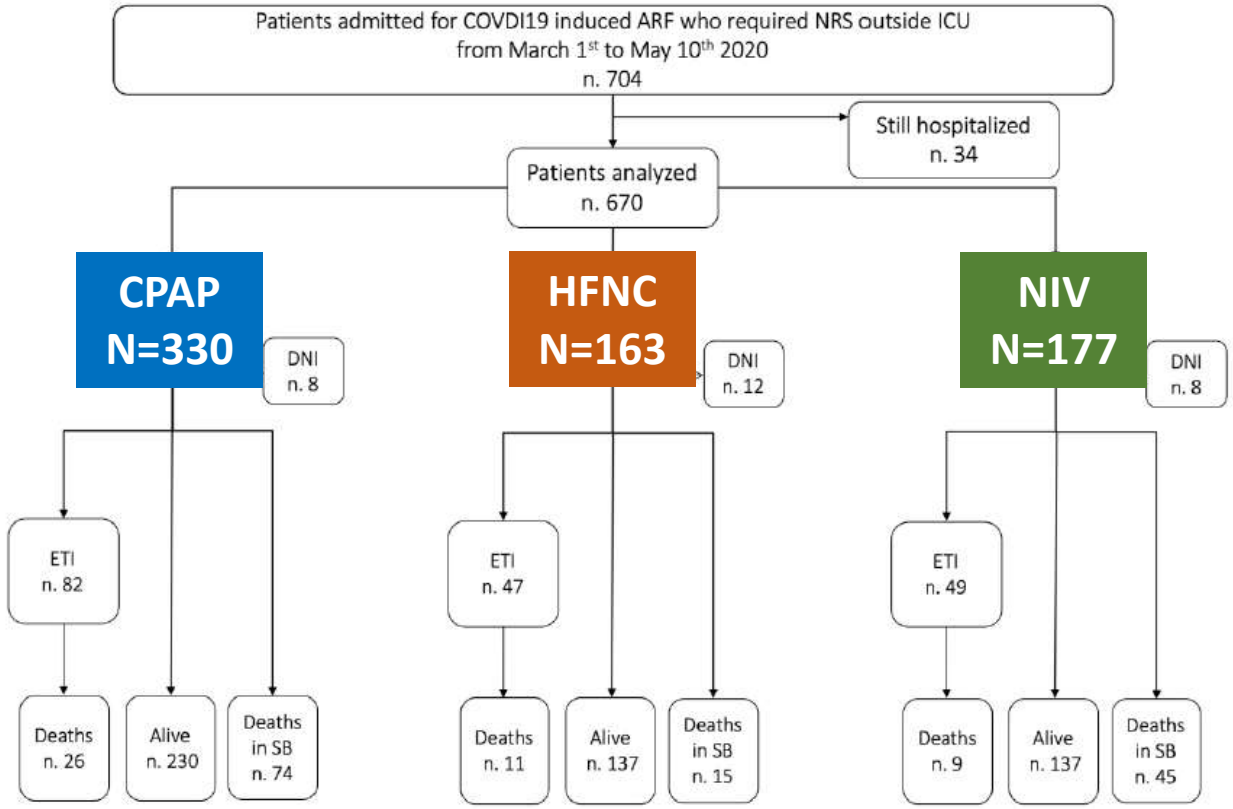
At day 28

- **% of patients requiring IMV**
  HFNO vs no-HF 55 vs. 72%
- **Mortality**
  HFNO vs no-HF 21% vs. 22%

Feasibility and clinical impact of out-of-ICU non-invasive respiratory support in patients with COVID-19 related pneumonia

Franco C et al, ERJ 2020; in press

Outside ICU 670 patients
HFNO, CPAP, NIV



ITALIAN Guidelines- four patient categories:

- ❑ **green** (SaO2 >94%, RR <20 breaths/min
- ❑ **yellow** (SaO2 <94%, RR >20 breaths/min but responds to oxygen 10–15 L·min−1)
- ❑ **orange** (SaO2 <94%, RR 25–30 breaths/min but poor response to oxygen 10–15 L/min and requires CPAP/NIV with FIO2<50%
- ❑ **red** (SaO2 <94%, RR >30 breaths/min but poor response to oxygen 10–15 L/min, CPAP/NIV with FIO2 >50% or presenting respiratory distress with PaO2/FIO2 <200 and needing endotracheal intubation (EI) and ICU admission

Patients were continuously monitored with

- electrocardiogram trace
- noninvasive blood pressure
- arterial oxygen saturation
- respiratory rate

TWO units -wards

1st : 1:4 to 1:6 nurse : patient ratio

2nd: 1:2 to 1:4 nurse : patient ratio

30-day mortality rate 26.9%

ETI rate:27%

Variable	Total n=670 (100%)	HFNC N=163 n= 163 (24.3%)	CPAP N=330 n= 330 (49.3%)	NIV N=177 = 177 (26.4%)	p value
Age, years (SD)	68.3 (13.3)	65.7 (14.7)	70.3 (12.1)	66.8 (13.5)	<0.001
Male, n (%)	464 (69.3)	114 (69.9)	223 (67.6)	127 (71.8)	n.s. (0.6)
SOFA, score (SD)	3.3 (1.7)	2.5 (0.9)	3.3 (1.7)	4 (1.9)	<0.0001
PaO_2/FiO_2, mmHg (SD)	152 (79)	166 (65)	151 (90)	138 (66)	<0.01
Respiratory rate, bpm (SD)	28 (7)	25 (5)	28 (7)	31 (7)	<0.0001

The three modes of NRS had a **similar impact on mortality** outcome, as well as on **intubation rate** and **length of stay**

the mortality rate increased with

- ❑ **age**: <69 vs >69 years: 12.5% vs 41.2%
- ❑ **highly comorbid patients** : >2 vs <2 comorbidities: 34.4% vs 19.6%

Franco C et al, ERJ 2020; in press

BMJ Open Respiratory Research

Retrospective analysis of high flow nasal therapy in COVID-19-related moderate-to-severe hypoxaemic respiratory failure

Patel M, et al. BMJ Open Resp Res 2020;7:e000650

retrospective analysis of consecutive patients admitted to Temple University Hospital in Philadelphia, Pennsylvania

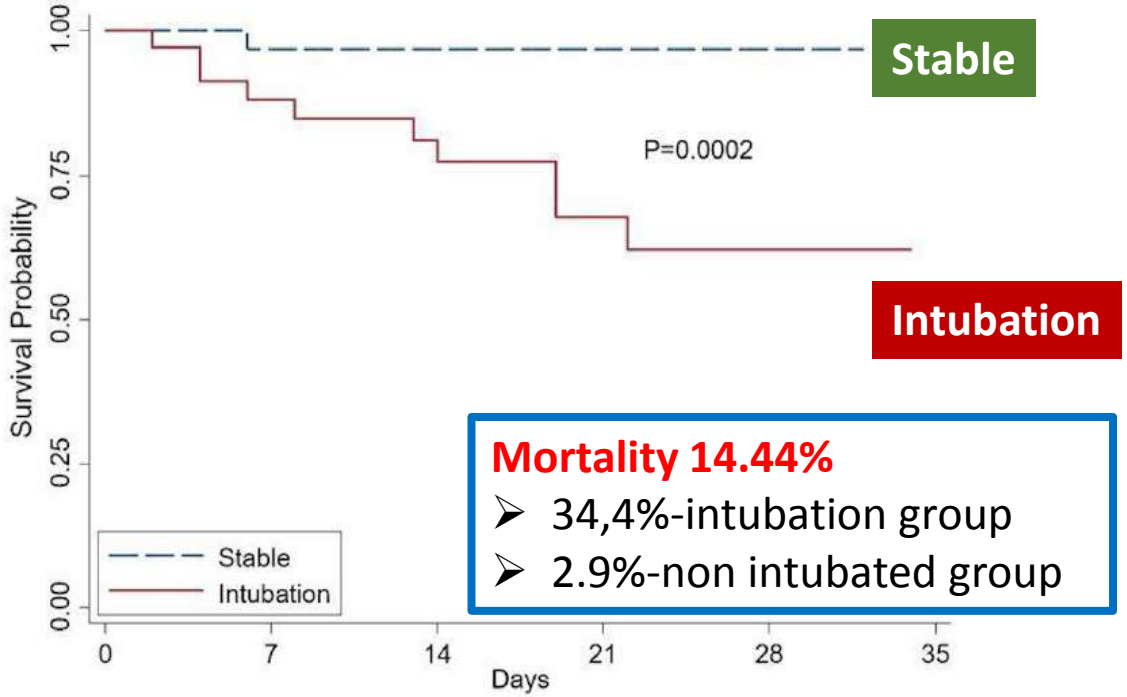
- **104 patients HFNO**
- Moderate severe RF
- >15lt/min oxygen

mean Saturation/Fraction (S/F) ratio
121.9 (range 79–225)

primary outcome: prevention of IMV (%) with use of HFNT

- 64.42% **avoided intubation**
- 35,58 % **progressed to IMV**
- 7,69% **required NIV**

Survival Probability

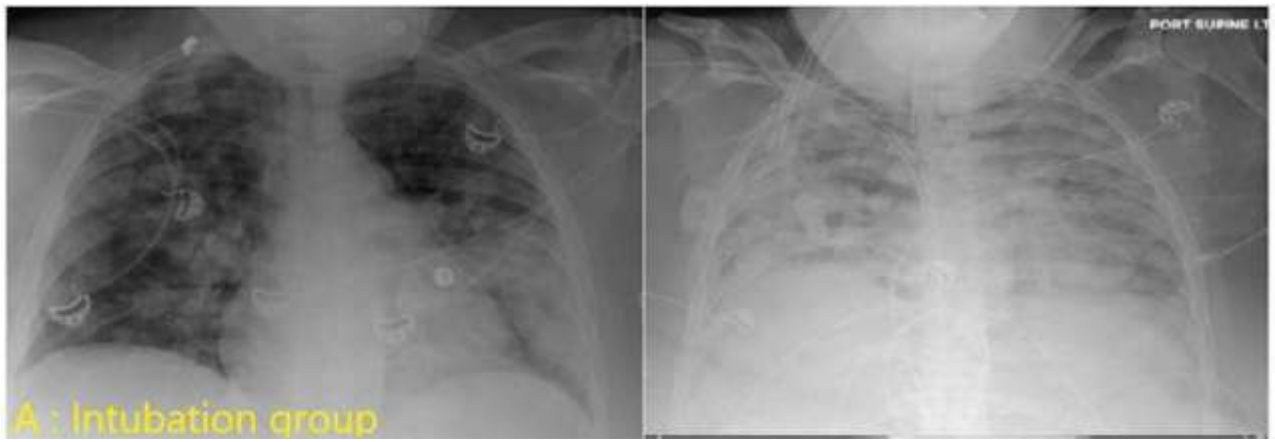


Mortality 14.44%

- 34,4%-intubation group
- 2.9%-non intubated group

Comparing outcomes between intubation and non-intubation groups

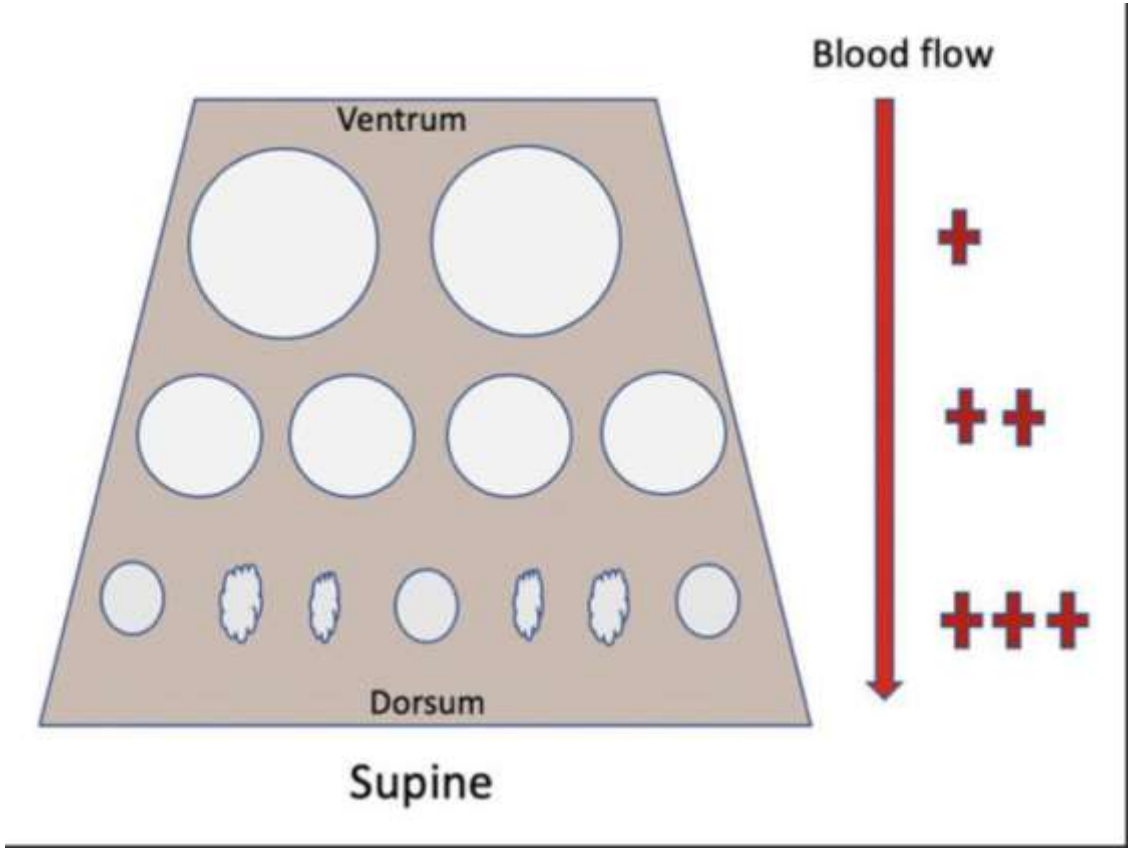
Outcomes	Intubation	Non-intubation	P value
Mortality	13 (35.1%)	2 (2.9%)	0.0018
Hospital LOS (days)	13.67 (±7.97)	9.7 (±4.6)	0.03
ICU LOS (days)	10.45 (±6.12)	4.05 (±2.64)	0.0008
HAP/VAP incidence	3 (8.57%)	0	0.017
Change in SF ratio	40.5 (±67.90)	141.4 (±117.14)	0.0001
Change in CXR RALES	−0.13 (±11.18)	−3.2 (±8.50)	0.09
Change in HR (beats/min)	−7.65 (±20.69)	−7.95 (±19.19)	0.94
Change in RR (breaths/min)	−2.32 (±9.32)	−4.4 (±8.39)	0.27



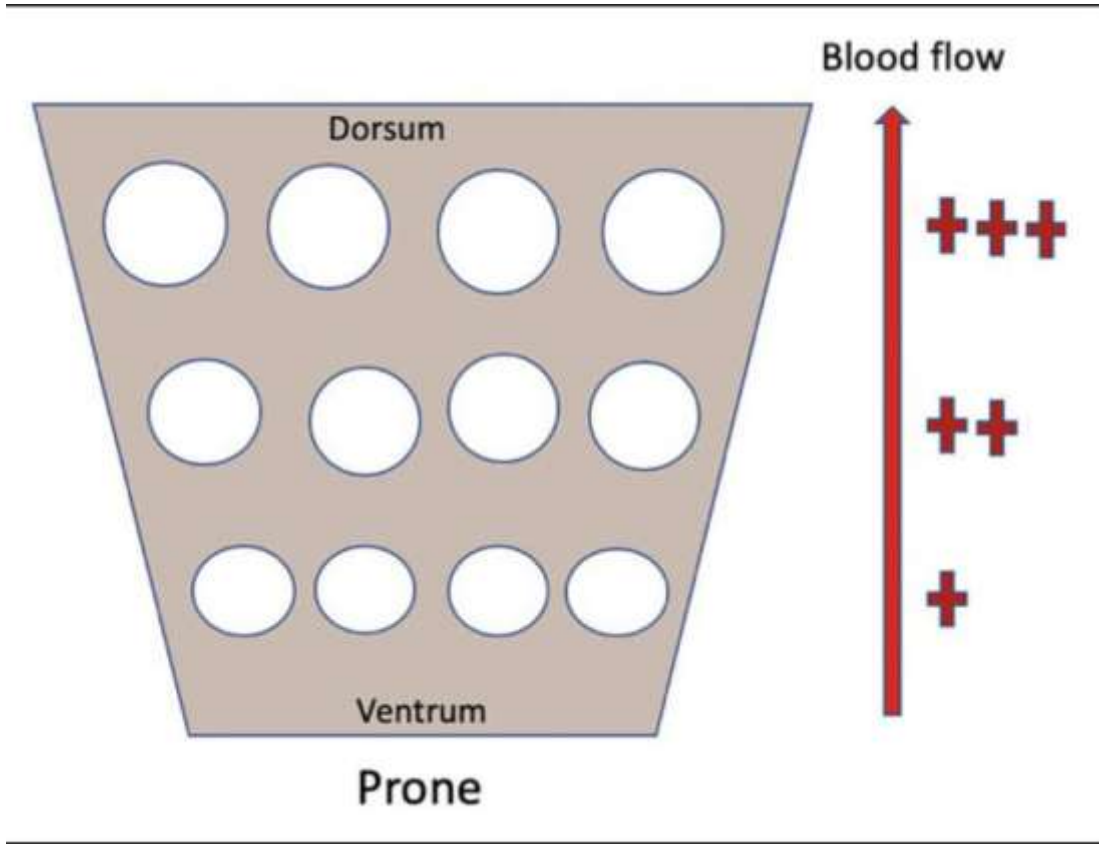
Patel M, et al. BMJ Open Resp Res 2020;7:e000650

AWAKE PRONE POSITIONING

SUPINE vs PRONE POSITIONING



- **Alveolar collapse** at bases due to lower TPP.
- **Alveolar overdistention** in the ventral areas due to higher TPP

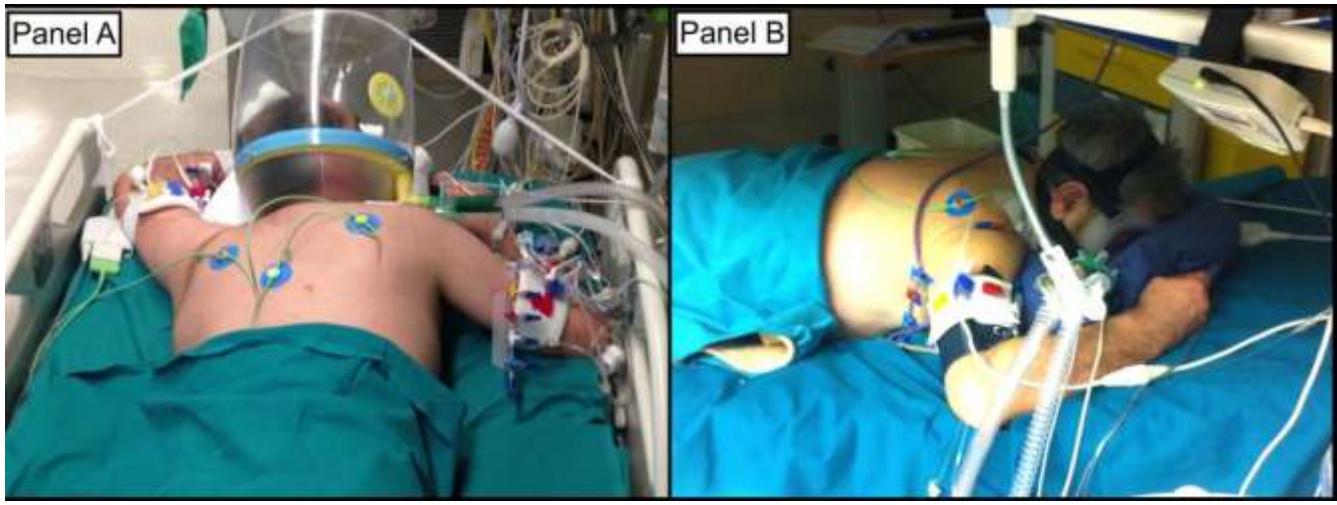


- **Recruitment of alveoli in dorsal lung**.
- **Less overdistention in the ventral lung**.
- **Improved V/Q matching** - blood flow pattern remains unaffected

Paul V et al J Intens Care Med. 2020; 35(8):818–824

Prone positioning improves oxygenation in spontaneously breathing nonintubated patients with hypoxemic acute respiratory failure: a retrospective study

Scaravilli V et al J Crit Care 2015

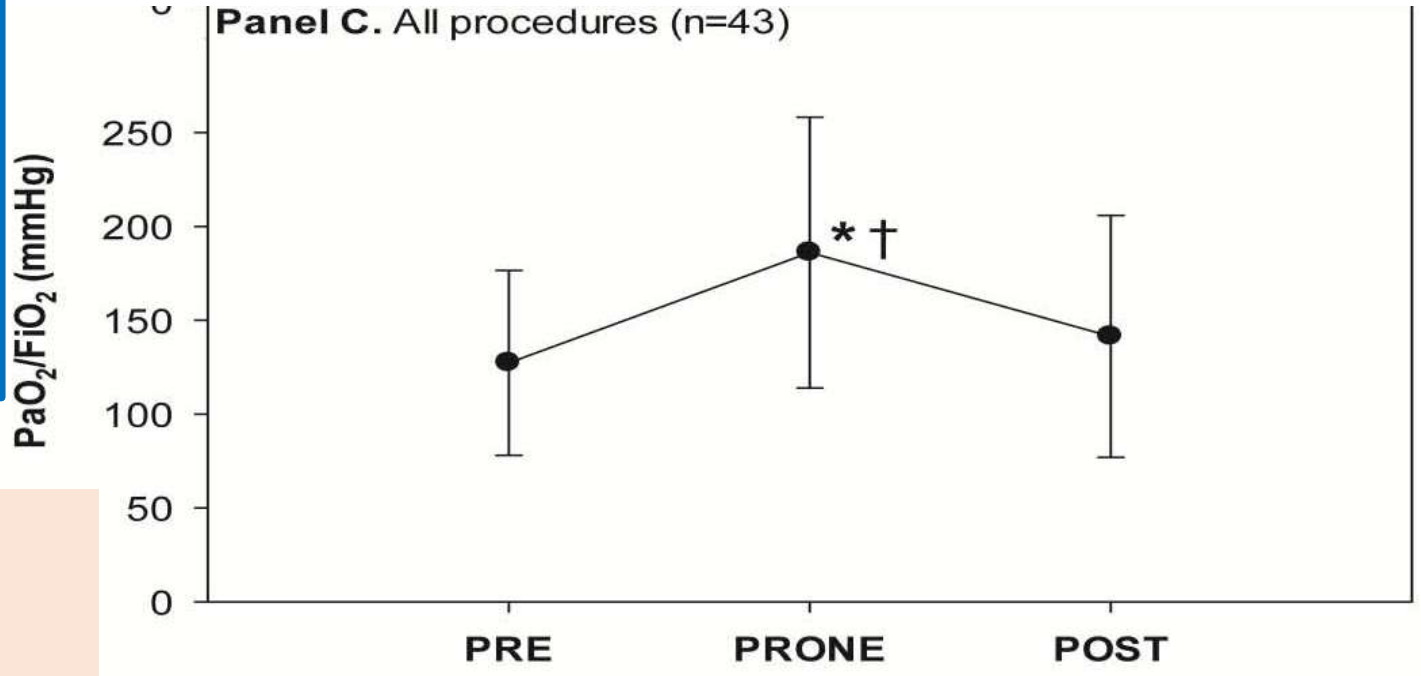


- ICU in Italy, **2009-2014**
- **15** non intubated, ARF, **PaO2/FiO2<300**
- 9 immunocompromised
- **Mainly pneumonia**

- median of 2 (1-3) procedures/subject
- median duration PP cycles: 3 (2-4) h, max 8h
- 2 intubated

step PRE: 1 to 2 hours before pronation
step PRONE: the last hour of PP
step POST: 6 to 8 hours after resupination

significant improvement in oxygenation



Feasibility and physiological effects of prone positioning in non-intubated patients with acute respiratory failure due to COVID-19 (PRON-COVID): a prospective cohort study

- Patients from: medical wards, ED, the respiratory HDU
- COVID-19-related pneumonia requiring supplemental oxygen or non-invasive CPAP

Prone position for at least 3 h

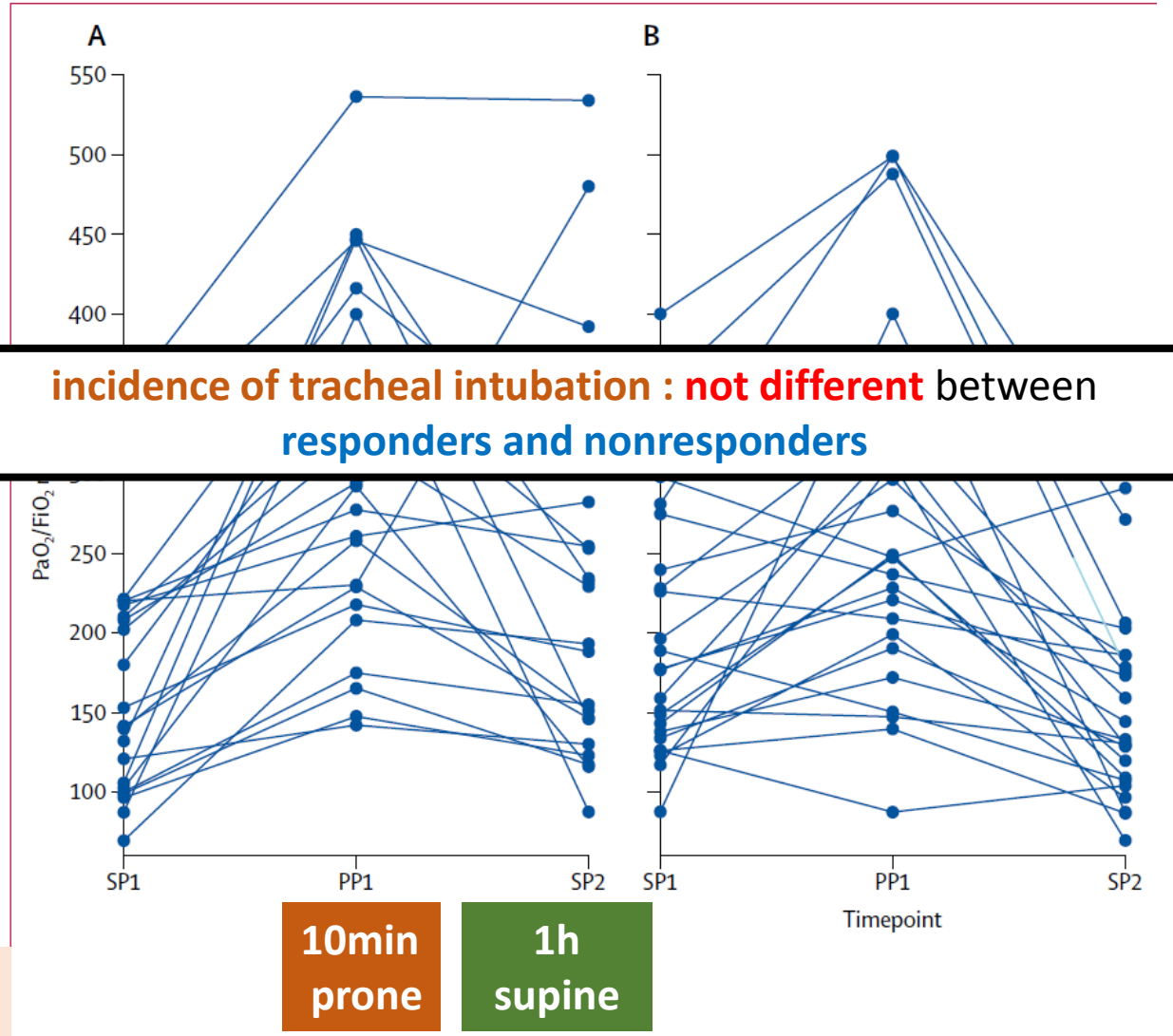
- Prone feasible in 47 patients -83.9%
  - 79% CPAP
  - 12% oxygen face mask
- 32% intubated

prone positioning in awake, spontaneously breathing patients

- is feasible outside ICU in most patients.
- improved oxygenation - this effect was lost after reverting to the supine position
- improvement in oxygenation maintained upon resupination by half of the patients for at least 1 h

Responders
10-20%↑ PaO2/FiO2 SP1-SP2

Non- responders



incidence of tracheal intubation : not different between responders and nonresponders

Coppo A et al Lancet Respir Med 2020;8: 765–74

WHO- Management of severe COVID-19: severe pneumonia

Prone position for **awake, spontaneously breathing patients** **may also improve oxygenation and the ventilation/perfusion ratio, but evidence is lacking and should be done under clinical trial protocol to assess efficacy and safety**

NIH Guideline

For patients with persistent hypoxemia despite increasing supplemental oxygen requirements in whom endotracheal intubation is not otherwise indicated, the **Panel recommends considering a trial of awake prone positioning to improve oxygenation** (CIII).

- **The Panel recommends against using awake prone positioning as a rescue therapy for refractory hypoxemia to avoid intubation in patients who otherwise require intubation and mechanical ventilation** (AIII).

AWAKE PRONE POSITIONING

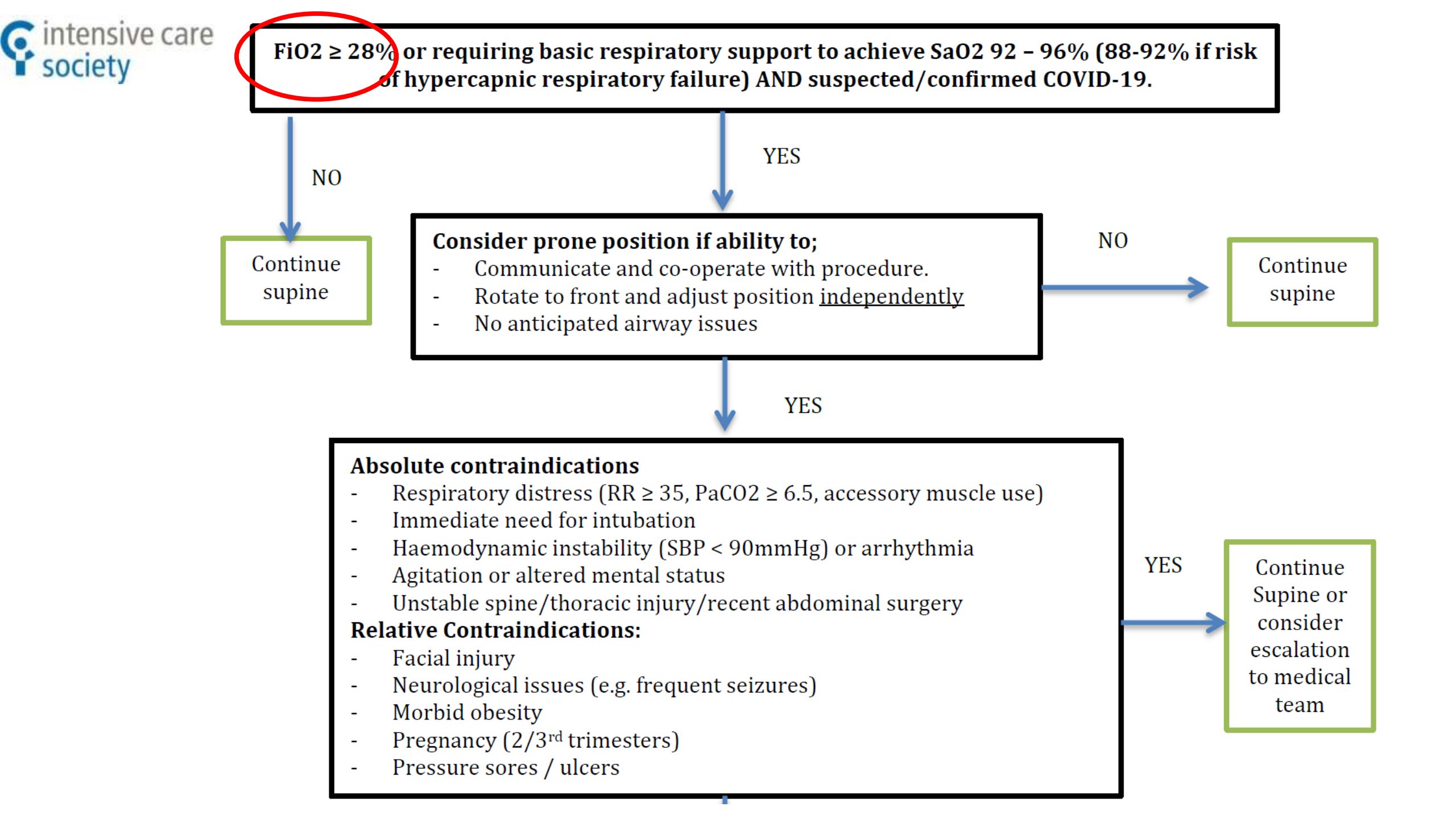
Prone positioning is a **simple intervention** that **can be done in most circumstances**, **is compatible with all forms of basic respiratory support** and **requires little or no equipment** in the conscious patient.

Given its potential for improving oxygenation in COVID-19 patients we advocate that **a trial of conscious prone positioning be performed on all suitable patients on the ward**

Timed Position Changes:

If patient fulfils criteria for proning ask the patient to switch positions as follows. Monitor oxygen saturations 15 minutes after each position change to ensure oxygen saturation has not decreased. Continue to monitor oxygen saturations as per the National Early Warning Score (NEWS)

- 30 minutes to 2 hours lying fully prone (bed flat)
- 30 minutes to 2 hours lying on right side (bed flat)
- 30 minutes to 2 hours sitting up (30-60 degrees) by adjusting head of the bed
- 30 minutes to 2 hours lying on left side (bed flat)
- 30 minutes to 2 hours lying prone again
- Continue to repeat the cycle.....


intensive care society
FiO2 ≥ 28% or requiring basic respiratory support to achieve SaO2 92 – 96% (88-92% if risk of hypercapnic respiratory failure) AND suspected/confirmed COVID-19.
NO
Continue supine
YES
Consider prone position if ability to;
- Communicate and co-operate with procedure.
- Rotate to front and adjust position independently
- No anticipated airway issues
NO
Continue supine
YES
Absolute contraindications
- Respiratory distress (RR ≥ 35, PaCO2 ≥ 6.5, accessory muscle use)
- Immediate need for intubation
- Haemodynamic instability (SBP < 90mmHg) or arrhythmia
- Agitation or altered mental status
- Unstable spine/thoracic injury/recent abdominal surgery
Relative Contraindications:
- Facial injury
- Neurological issues (e.g. frequent seizures)
- Morbid obesity
- Pregnancy (2/3rd trimesters)
- Pressure sores / ulcers
YES
Continue Supine or consider escalation to medical team

Protocol for awake prone positioning in COVID-19 patients

Guy Bower and Hangyong He, Crit Care (2020) 24:371