Oxygenation and Ventilation
in Covid 19

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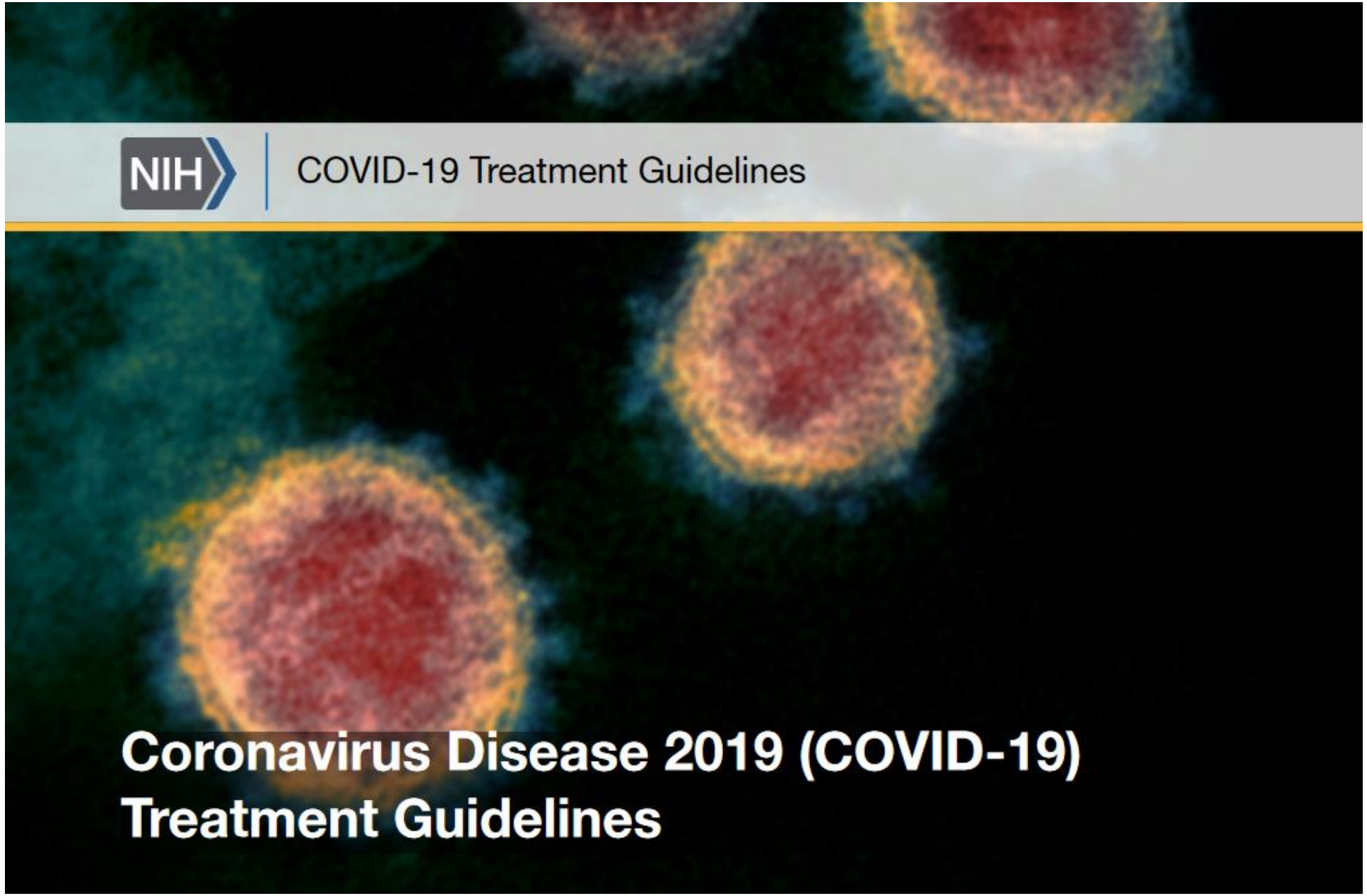


https://www.covid19treatmentguidelines.nih.gov/ on 10/19/2021

most common symptom

- Dyspnea
- Hypoxemia
- acute respiratory distress syndrome (ARDS).

Goal of Oxygenation

- The optimal oxygen saturation (SpO_2) in adults with COVID-19 who are receiving supplemental oxygen is uncertain
- However, a target SpO_2 of 92% to 96% seems logical
- SpO_2 <92% or >96% may be harmful.

Oxygen therapy liberal or conservative?

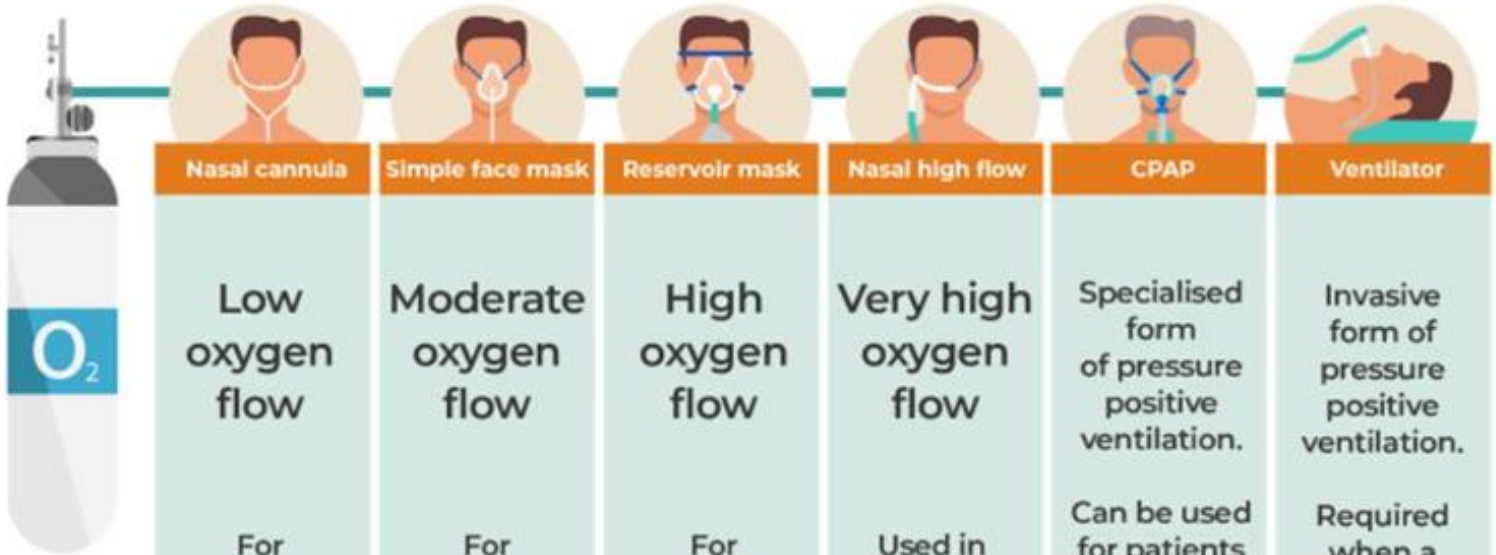
- SpO_2 <92% potentially harmful
- a liberal oxygen strategy (median SpO_2 of 96%) was associated with an increased risk of in-hospital mortality when compared to a more conservative SpO_2 strategy

Acute Hypoxemic Respiratory Failure in covid

- conventional oxygen therapy may be insufficient to meet the oxygen needs of the patient
- high-flow nasal canula (HFNC) oxygen
- noninvasive positive pressure ventilation (NIPPV)
- intubation and invasive mechanical ventilation
- extracorporeal membrane oxygenation

COVID-19

Types of oxygen therapy



	Nasal cannula	Simple face mask	Reservoir mask	Nasal high flow	CPAP	Ventilator
	Low oxygen flow For regular hospital and home care.	Moderate oxygen flow For regular hospital and home care.	High oxygen flow For hospital care.	Very high oxygen flow Used in situations of respiratory failure.	Specialised form of pressure positive ventilation. Can be used for patients with apnea or to maintain an open airway.	Invasive form of pressure positive ventilation. Required when a patient's lungs are severely impaired.
OXYGEN FLOW	**1-6** Litres/min	**5-10** Litres/min	**15** Litres/min	**UP TO 70** Litres/min	**15** Litres/min	**AS PER LIFE SUPPORT NEEDS**
FIO2* FRACTION OF INSPIRED OXYGEN	**24-50%**	**40-60%**	**60-90%**	**UP TO 100%**	**UP TO 100%**	**UP TO 100%**

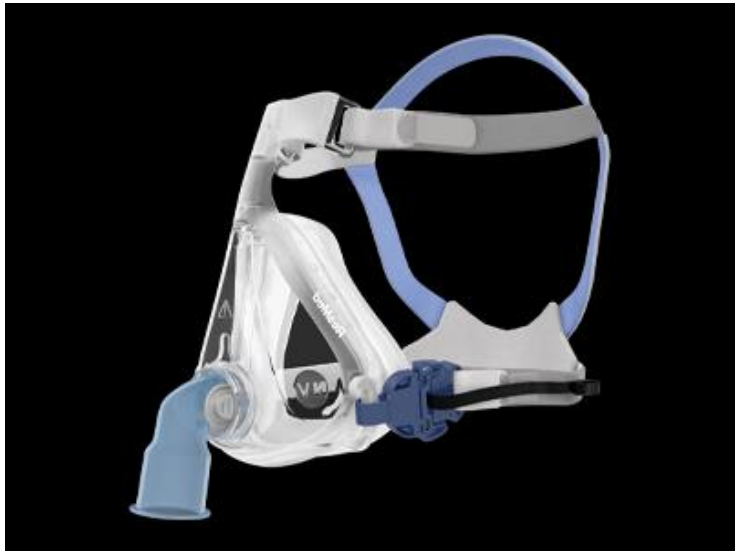
mechanical ventilation

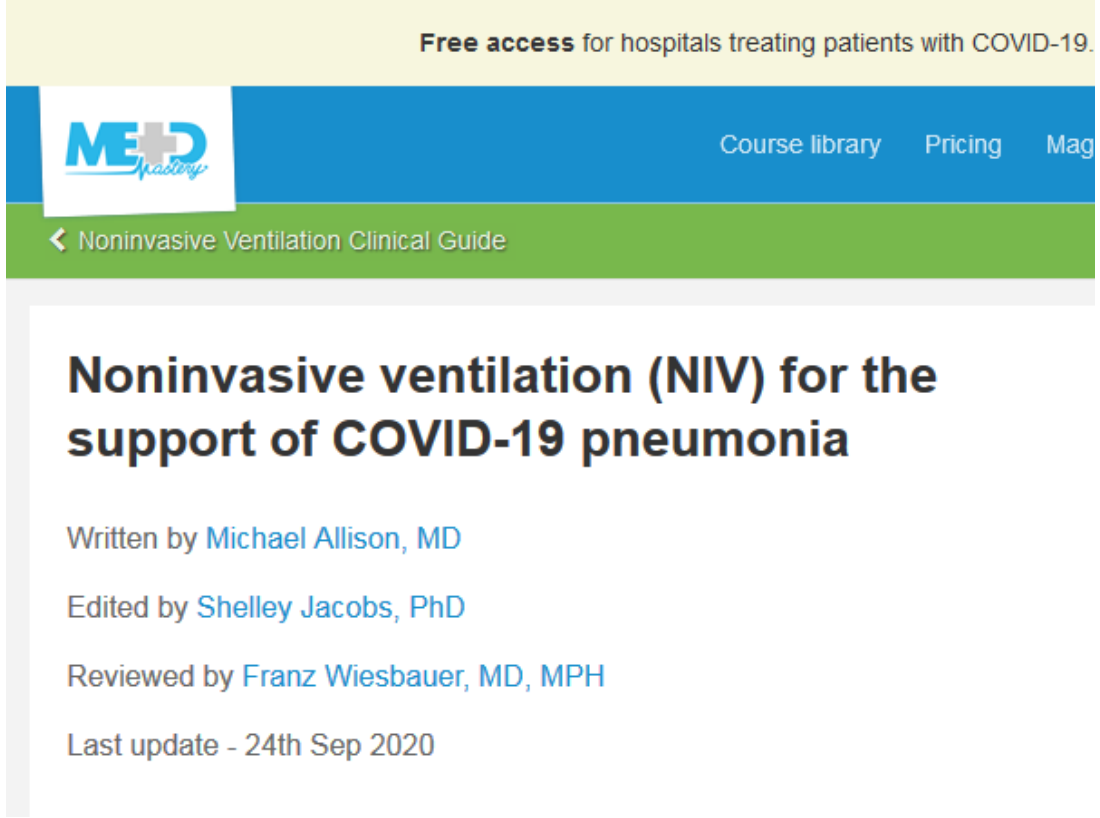
- **Non-invasive ventilation (NIV)** is a form of mechanical ventilation where air is delivered to the patient through a mask or mouthpiece.
- **Invasive ventilation (IV)** is used when sufficient ventilation cannot be achieved using non-invasive methods; air is delivered through a tube inserted into the trachea either by intubation or tracheotomy.

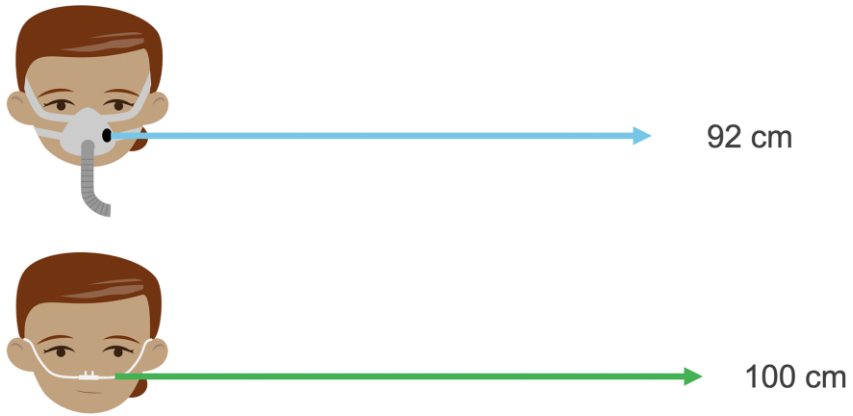
	COMFORT COUGH Seoil Pacific Corporation Korea	Positive Pressure +5 to +60 cmH_2O Negative Pressure -5 to -60 cmH_2O	Modes Manual Automatic
	PEGASO COUGH Dima Italia Italy	Positive Pressure 0 to +70 cmH_2O Negative Pressure -0 to -70 cmH_2O	Modes Manual Automatic Autoajusted Percussion
	NIPPY CLEARWAY B&D Electromedical United Kingdom	Positive Pressure 0 to +60 cmH_2O Negative Pressure 0 to -60 cmH_2O	Modes Manual Automatic NIV
	COUGHASSIST E70 Philips Netherlands	Positive Pressure 0 to +70 cmH_2O Negative Pressure 0 to -70 cmH_2O	Modes Manual Automatic Autoajusted

es

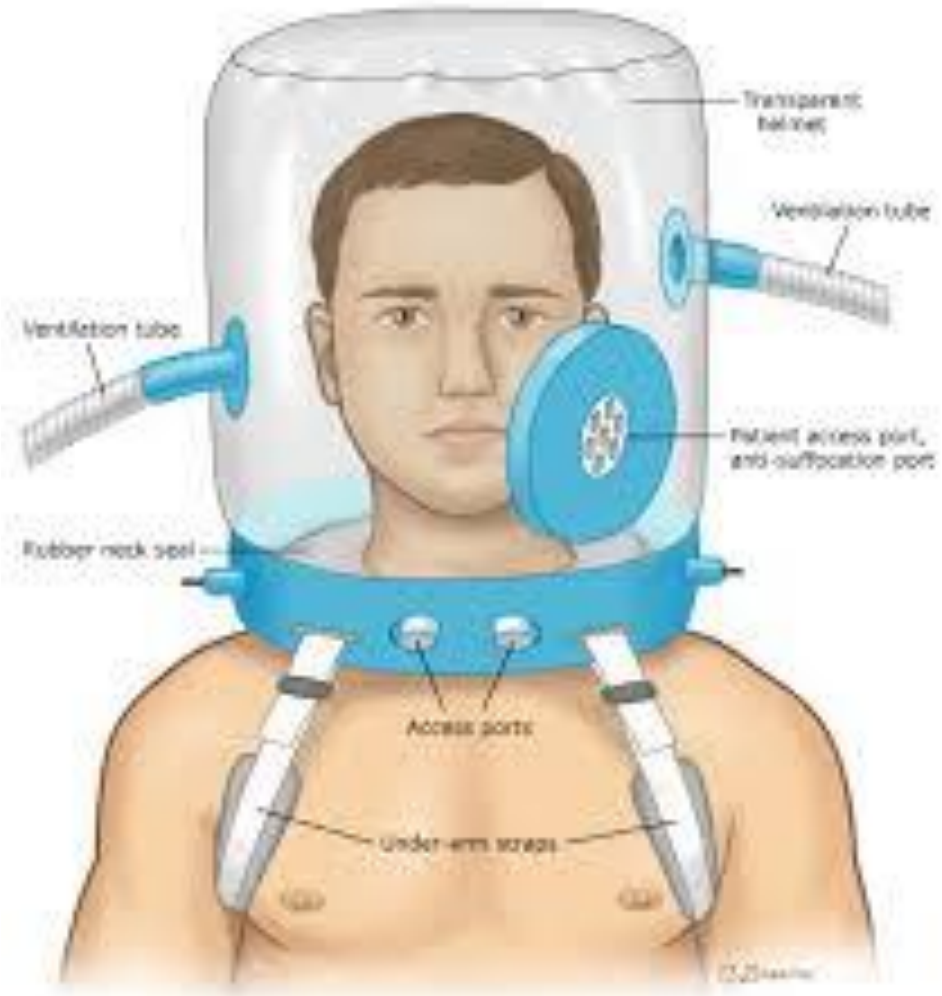
NIV mouthpiece





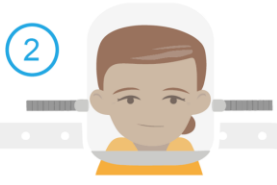


- traditional nasal cannula at 5 L / min a dispersion of 100 cm.
- When there's a leak or a valve in a NIV mask, on a bilevel setting (BPAP) with an inspiratory positive airway pressure (IPAP) of 18 cmH_2O, maximal dispersion in a negative pressure room was measured at 92 cm.


Transparent helmet
Ventilation tube
Ventilation tube
Patient access port, anti-suffocation port
Rubber neck seal
Access ports
Under-arm straps

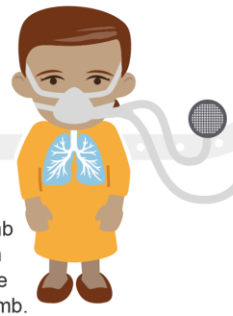
5 steps of using noninvasive ventilation (NIV) for patients with COVID-19

1. Use a negative pressure room.



2. Choose a helmet or full-face mask.

3. Use dual limb circuitry with a filter on the expiratory limb.



4. Use continuous positive airway pressure (CPAP) with pressures between 5 and 8 cmH_2O.

5. Reevaluate the patient within the first few hours and intubate if needed.

*Noninvasive ventilation should **not be routinely used** in patients with COVID-19. And if it is used, make sure to follow the steps outlined here to deliver noninvasive ventilation safely.*


Oxygen flowmeter
ventilator circuit

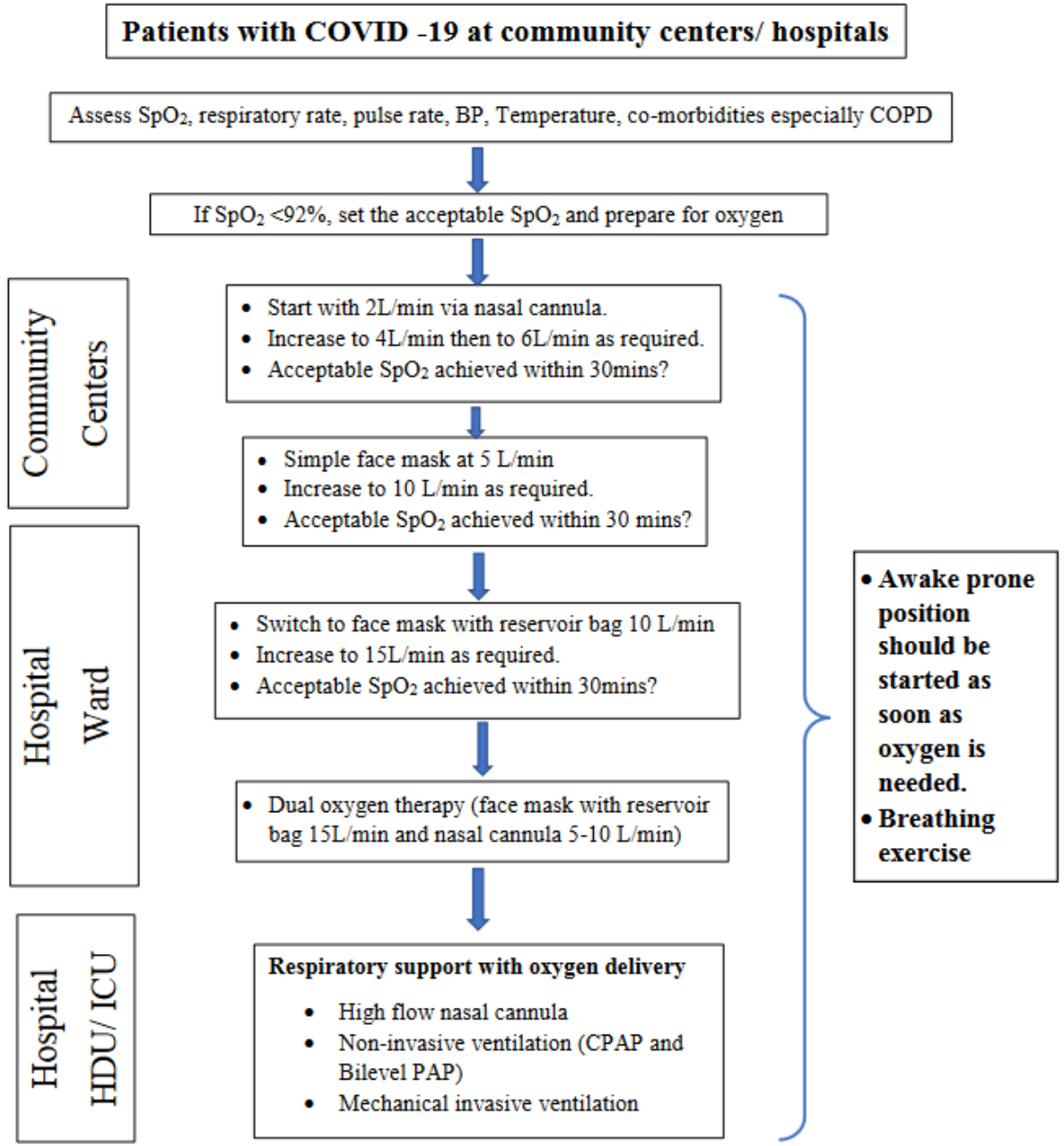
General assessments

co-morbidities
oxygen saturation level (SpO2%)
Vital signs -Temperature, BP, PR, Respiratory rate and respiratory distress, conscious level
Available oxygen sources

Oxygen administration and delivery devices

- nasal cannulae at 2–6 L/min (preferably)
- simple face mask at 5–10 L/min
  saturation below 85%,
  treatment should be started with a reservoir mask at 15 L/min
- coexisting COPD saturation of 88–92%.

- Maternal peripheral oxygen saturation (SpO2) should be maintained at ≥ 95 % in patients with COVID -19 during pregnancy



*** Always use the lowest flow rate possible to achieve target SpO_2 as Oxygen likely to be in short supply in the hospital.**

*** Initial oxygen therapy step is depending on the existing SpO_2 of the patients**

*** To reduce the oxygen level when the acceptable SpO_2 level is achieved in stable patients**

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Critical Care

LETTER Open Access

Non-invasive ventilation in the treatment of early hypoxemic respiratory failure caused by COVID-19: considering nasal CPAP as the first choice

Lili Guan[1†], Luqian Zhou[1†], Jehane Michael Le Grange[2†], Zeguang Zheng[1†] and Rongchang Chen[3*]

Combination of both NIV and HFNC

Frat JP et al.,[33] in patients with PaO_2/FiO_2 <300, studied the effect of sequential application of sessions of HFNC and NIV. Intubation was required in 36% of patients, including individuals with ARDS. Authors concluded that due to the good tolerance and efficacy on oxygenation, HFNC could be a good option to be used between NIV sessions to pursue a coupled non invasive strategy of ventilation without a marked impairment of oxygenation.

In awake, non-intubated, spontaneously breathing patients with hypoxemic ARF (majorly immunocompromised) Scaravilli et al.,[29] showed a significant improvement in PaO_2/FiO_2 with prone positioning. More recently, early prone positioning added to HFNC or NIV avoided the need for intubation in up to half of the patients with moderate to severe ARDS including those with viral pneumonia.[30] No health care professional was infected during this study carried out in isolation negative pressure rooms. Other authors report similar results[31] and a randomized controlled trial is ongoing.[32]

Table 1 Exhaled air dispersion according with modalities and interfaces.[43–46]

Interfaces and pressures (in cmH20)	Maximum exhaled air distance (in meters)
ResMed Ultra Mirage mask IPAP/EPAP cmH_2O	
10/4	0.40
14/4	0.42
18/4	0.45
ResMed Quattro Air mask (with anti-asphixia valve closed)	
CPAP 10–20 cmH20	Negligible
Respironics Total Face IPAP/EPAP cmH20	
10/5	0.61
18/5	0.81
Helmet StarMed CaStar R IPAP/EPAP cmH20	
IPAP from 12 to 20/EPAP 5	Negligible

Abbreviations: CPAP, continuous positive airway pressure; IPAP, inspiratory positive airway pressure; EPAP, expiratory positive airway pressure.

COVID-19 disease: Non-Invasive Ventilation and high frequency nasal oxygenation

Chris Carter

Helen Aedy

Joy Notter

Abstract

Severe COVID-19 causes significant numbers of patients to develop respiratory symptoms that require increasing interventions. Initially, the treatment for severe respiratory failure included early intubation and invasive ventilation, as this was deemed preferable to be more effective than Non-Invasive Ventilation (NIV). However, emerging evidence has shown that NIV may have a more significant and positive role than initially thought. NIV includes Continuous Positive Airway Pressure (CPAP) and Bi-Level Positive Airway Pressure (BiPAP). CPAP is the method of choice with the use of BiPAP for those with complex respiratory conditions who contract COVID-19. The use of High Flow Nasal Oxygen (HFNO) remains contentious with different perspectives in how this modality can be used to treat respiratory failure in COVID-19.

Current thinking suggests that NIV and HFNO may be an appropriate bridging adjunct in the early part of the disease progress and may prevent the need for intubation or invasive ventilation. Patients requiring NIV or HFNO may be nursed in locations outside of the critical care unit. Therefore, this article reviews the different types of NIV and HFNO, indications and the nursing care.

Keywords 2019-nCOV; COVID-19; critical care; high flow nasal oxygen; non-invasive ventilation; SARS-CoV2

EUROPEAN RESPIRATORY *journal*

FLAGSHIP SCIENTIFIC JOURNAL OF ERS

Early View

Original article

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

Cosimo Franco, Nicola Facciolongo, Roberto Tonelli, Roberto Dongilli, Andrea Vianello, Lara Pisani, Raffaele Scala, Mario Malerba, Annalisa Carlucci, Emanuele Alberto Negri, Greta Spoladore, Giovanna Arcaro, Paolo Amedeo Tillio, Cinzia Lastoria, Gioachino Schifino, Luca Tabbi', Luca Guidelli, Giovanni Guaraldi, V. Marco Ranieri, Enrico Clini, Stefano Nava

Table 2. Fraction of active professional health care workers and percentage of infection

Role	At work	Infected
Physician, n (%)	108	8 (7.4)
Nurse, n (%)	210	29 (13.8)
Health care worker, n (%)	45	5 (11)
Physiotherapist	16	0 (0)
Total	369	42 (11.4)

Two different phenotypes of patients have been hypothesized

- more than 50% of COVID-19 pneumonia with Berlin criteria of ARDS have normal lung compliance, with “silent” hypoxemia (the so called Type L phenotype)
- these patients when non dyspnoeic should just receive supplemental oxygen
- if dyspnoeic, should be offered HFNC, CPAP or NIV.
- If the patient shows significant increase in work of breathing, we should proceed to intubation and invasive mechanical ventilation

Non invasive ventilation and HFNC can be reserved for patients with

- mild ARDS
- with close monitoring
- airborne precautions
- preferably in single rooms

suspected or diagnosed COVID-19 requiring NIV

- helmets may be the best solution for CPAP or NIV,
- because of minimal or no dispersion from leaks,
- easy to filter/scavenge exhausted gas

If NIV is the option

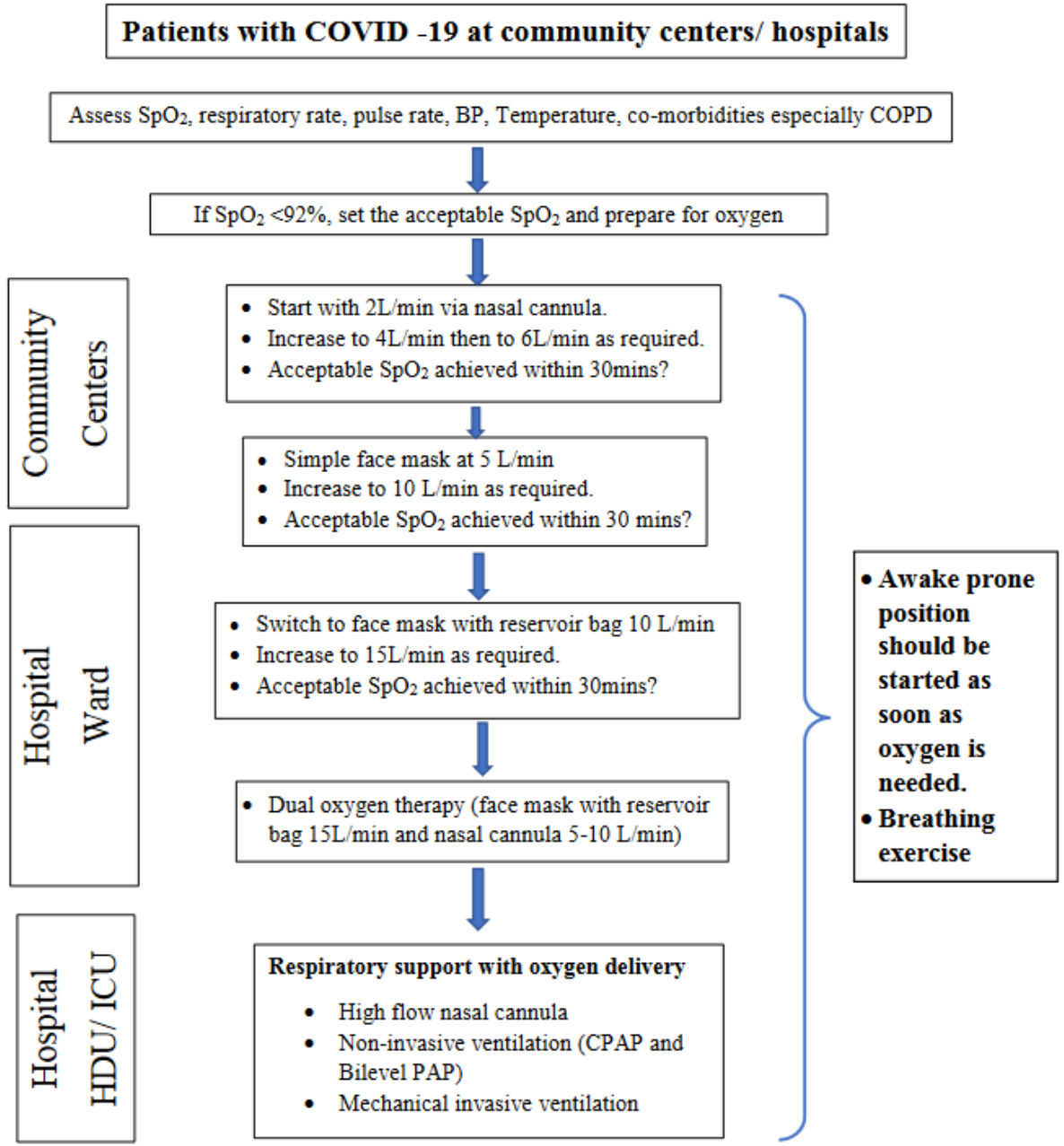
- try “protective-NIV” with lower tidal volumes between 6 and 8mL/kg

Signs of respiratory deterioration

Increased respiratory rate > 30/min
Decreased SpO2
Increased oxygen dose needed to keep SpO2 within acceptable range
Serial decreased ratio of SpO2/FiO2

Features of carbon dioxide retention

Drowsiness
Flapping tremor
Flushed face
Headache



*** Always use the lowest flow rate possible to achieve target SpO_2 as Oxygen likely to be in short supply in the hospital.**

*** Initial oxygen therapy step is depending on the existing SpO_2 of the patients**

*** To reduce the oxygen level when the acceptable SpO_2 level is achieved in stable patients**


HFNC
HIGH FLOW
NASAL CANNULA
Breathing tube
Nasal cannula
Heat device
Cart
HFNC

High-Flow Nasal Cannula Oxygen and Noninvasive Positive Pressure Ventilation Recommendations

- For adults with COVID-19 and acute hypoxemic respiratory failure despite conventional oxygen therapy, the Panel recommends HFNC oxygen over NIPPV (BIIa).
- For adults with COVID-19 and acute hypoxemic respiratory failure for whom HFNC oxygen is not available, in the absence of an indication for endotracheal intubation, the Panel recommends a closely monitored trial of NIPPV (BIIa)

High-flow nasal oxygen in patients with COVID-19-associated acute respiratory failure

Ricard Mellado-Artigas[1*], Bruno L. Ferreyro[2,3], Federico Angriman[3,4], María Hernández-Sanz[5], Egoitz Arruti[6], Antoni Torres[7,8,9], Jesús Villar[8,10,11], Laurent Brochard[3,11] and Carlos Ferrando[1,8] for the COVID-19 Spanish ICU Network

Abstract

Purpose: Whether the use of high-flow nasal oxygen in adult patients with COVID-19 associated acute respiratory failure improves clinically relevant outcomes remains unclear. We thus sought to assess the effect of high-flow nasal oxygen on ventilator-free days, compared to early initiation of invasive mechanical ventilation, on adult patients with COVID-19.

Methods: We conducted a multicentre cohort study using a prospectively collected database of patients with COVID-19 associated acute respiratory failure admitted to 36 Spanish and Andorran intensive care units (ICUs). Main exposure was the use of high-flow nasal oxygen (conservative group), while early invasive mechanical ventilation (within the first day of ICU admission; early intubation group) served as the comparator. The primary outcome was ventilator-free days at 28 days. ICU length of stay and all-cause in-hospital mortality served as secondary outcomes. We used propensity score matching to adjust for measured confounding.

Results: Out of 468 eligible patients, a total of 122 matched patients were included in the present analysis (61 for each group). When compared to early intubation, the use of high-flow nasal oxygen was associated with an increase in ventilator-free days (mean difference: 8.0 days; 95% confidence interval (CI): 4.4 to 11.7 days) and a reduction in ICU length of stay (mean difference: − 8.2 days; 95% CI − 12.7 to − 3.6 days). No difference was observed in all-cause in-hospital mortality between groups (odds ratio: 0.64; 95% CI: 0.25 to 1.64).

Conclusions: The use of high-flow nasal oxygen upon ICU admission in adult patients with COVID-19 related acute hypoxemic respiratory failure may lead to an increase in ventilator-free days and a reduction in ICU length of stay, when compared to early initiation of invasive mechanical ventilation. Future studies should confirm our findings.

Keywords: COVID-19, Acute hypoxemic respiratory failure, High-flow nasal oxygen, Ventilator-free days

Awake Prone Positioning in Nonmechanically Ventilated Adults

- persistent hypoxemia who require HFNC oxygen and for whom endotracheal intubation is not indicated, the Panel recommends a trial of awake prone positioning (BIIa).

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

Appropriate candidates for awake prone positioning

- those who can adjust their position independently and tolerate lying prone
- Awake prone positioning is acceptable and feasible for pregnant patients

Awake proning may be infeasible or impractical in patients with:

- Spinal instability
- Facial or pelvic fractures
- An open chest or unstable chest wall

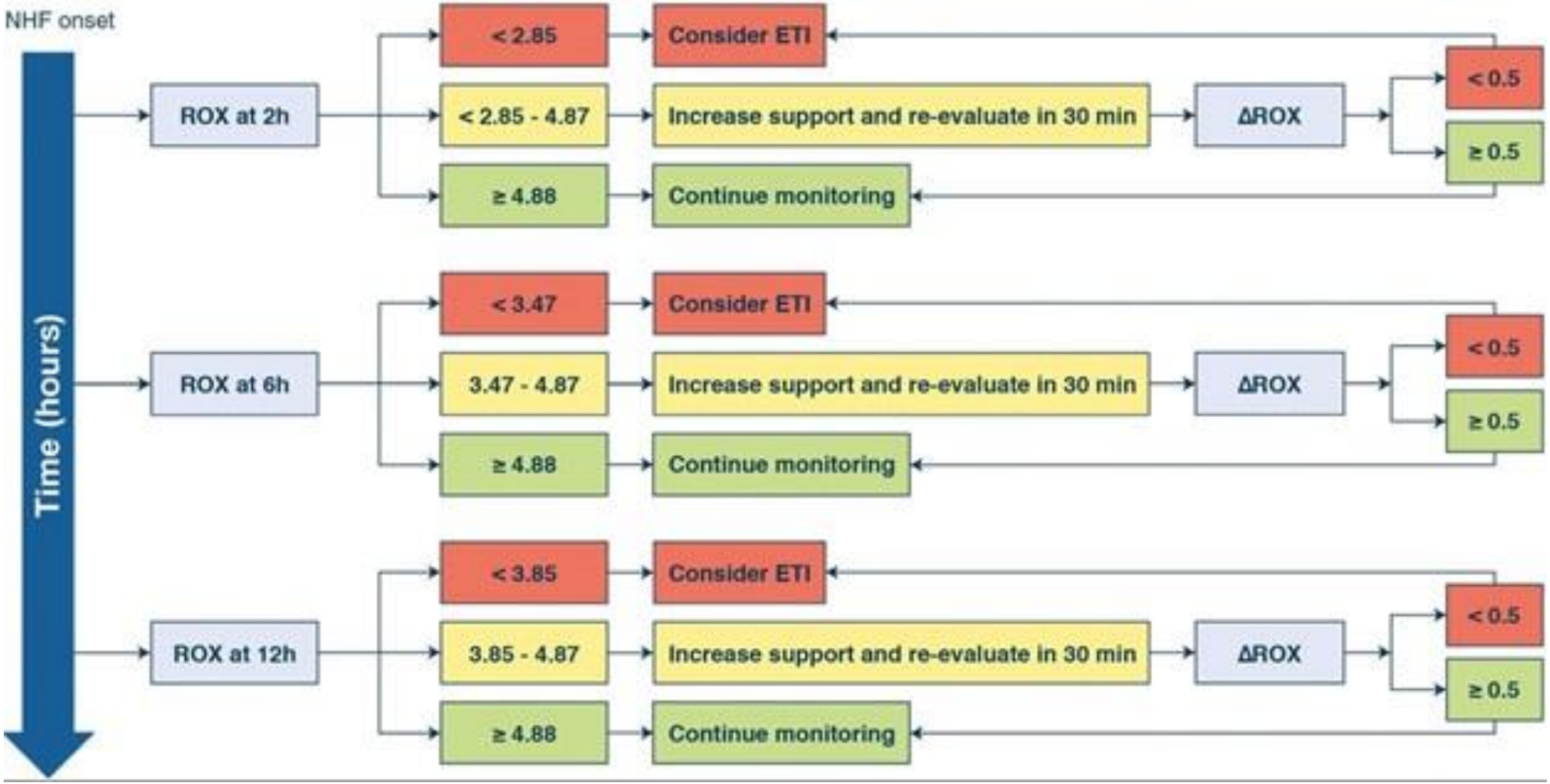
- Awake prone positioning should be used with caution in patients with
- confusion or delirium
- hemodynamic instability
- an inability to independently change position
- recent abdominal surgery
- recent nausea or vomiting

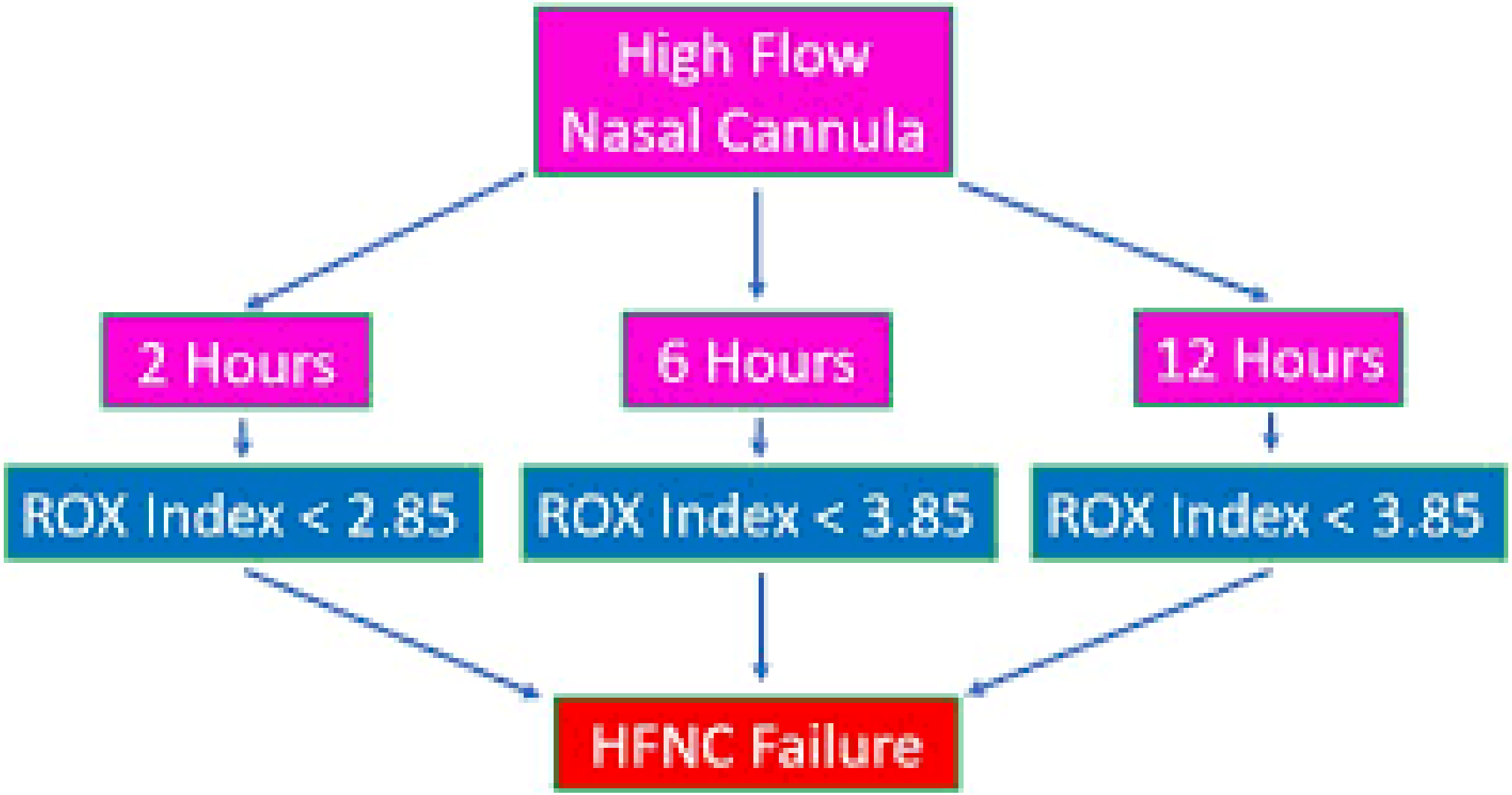
The failure of NIV

- intubation or death during the hospital stay
- worsening respiratory failure
- respiratory distress
- SpO2 below 88% without response toNIV
- respiratory acidosis with a pH below 7.30
- hemodynamic instability
- exhaustion

$$\text{ROX Index} = \frac{SPO_2/FIO_2}{\text{Respiratory Rate}}$$

Respiratory rate - OXygenation


NHF onset
Time (hours)
ROX at 2h
< 2.85
Consider ETI
< 2.85 - 4.87
Increase support and re-evaluate in 30 min
ΔROX
< 0.5
≥ 0.5
≥ 4.88
Continue monitoring
ROX at 6h
< 3.47
Consider ETI
3.47 - 4.87
Increase support and re-evaluate in 30 min
ΔROX
< 0.5
≥ 0.5
≥ 4.88
Continue monitoring
ROX at 12h
< 3.85
Consider ETI
3.85 - 4.87
Increase support and re-evaluate in 30 min
ΔROX
< 0.5
≥ 0.5
≥ 4.88
Continue monitoring


High Flow
Nasal Cannula
2 Hours
6 Hours
12 Hours
ROX Index < 2.85
ROX Index < 3.85
ROX Index < 3.85
HFNC Failure

Intubation of covid patient

- personal protection is the priority.
- hand hygiene before and after all procedures.
- Wear a fit-tested N95 respirator, face protector such as a shield, gown, and gloves.
- Limit the number of health care providers in the room
- The most experienced anesthetist available should perform the intubation
- Standard monitoring, intravenous access, instruments, drugs, ventilator, and suction should be prechecked.
- Avoid awake fiberoptic intubation
- Consider using a glidescope or similar device.

Intubation of covid patient

- Plan for rapid sequence induction (RSI)
- if manual ventilation is required, small tidal volumes should be applied.
- Use 5 minutes of preoxygenation with 100% oxygen and RSI techniques to avoid manual ventilation of patient’s lungs and the potential aerosolization of virus from airways.
- Ensure that a high efficiency hydrophobic filter is interposed between facemask and breathing circuit or between facemask and a self-inflating ventilation bag such as a Laerdal bag.
- Intubate and confirm correct position of the tracheal tube.
- Institute mechanical ventilation and stabilize patient, as appropriate.
- All airway equipment must be decontaminated and disinfected according to appropriate hospital policies.
- After removing protective equipment, avoid touching hair or face before washing hands.

Mechanically Ventilation IN COVID

- using low tidal volume (VT) ventilation (VT 4–8 mL/kg of predicted body weight) (AI).
- targeting plateau pressures of <30 cm H2O (AIIa).
- conservative fluid strategy over a liberal fluid strategy (BIIa).
- NOT routine use of inhaled nitric oxide (AIIa)

Outcomes of COVID-19 patients intubated after failure of non-invasive ventilation: a multicenter observational study

Annalisa Boscolo[1,34], Laura Pasin[1,34], Nicolò Sella[2], Chiara Pretto[2], Martina Tocco[2], Enrico Tamburini[2], Paolo Rosi[3], Enrico Polati[4], Katia Donadello[4], Leonardo Gottin[4], Andrea Vianello[5], Giovanni Landoni[6], Paolo Navalesi[1,2]✉ & FERS, for the COVID-19 VENETO ICU Network*

The efficacy of non-invasive ventilation (NIV) in acute respiratory failure secondary to SARS-CoV-2 infection remains controversial. Current literature mainly examined efficacy, safety and potential predictors of NIV failure provided out of the intensive care unit (ICU). On the contrary, the outcomes of ICU patients, intubated after NIV failure, remain to be explored. The aims of the present study are: (1) investigating in-hospital mortality in coronavirus disease 2019 (COVID-19) ICU patients receiving endotracheal intubation after NIV failure and (2) assessing whether the length of NIV application affects patient survival. This observational multicenter study included all consecutive COVID-19 adult patients, admitted into the twenty-five ICUs of the COVID-19 VENETO ICU network (February–April 2020), who underwent endotracheal intubation after NIV failure. Among the 704 patients admitted to ICU during the study period, 280 (40%) presented the inclusion criteria and were enrolled. The median age was 69 [60–76] years; 219 patients (78%) were male. In-hospital mortality was 43%. Only the length of NIV application before ICU admission (OR 2.03 (95% CI 1.06–4.98), $p = 0.03$) and age (OR 1.18 (95% CI 1.04–1.33), $p < 0.01$) were identified as independent risk factors of in-hospital mortality; whilst the length of NIV after ICU admission did not affect patient outcome. In-hospital mortality of ICU patients intubated after NIV failure was 43%. Days on NIV before ICU admission and age were assessed to be potential risk factors of greater in-hospital mortality.

Positive End-Expiratory Pressure and Prone Positioning in Mechanically Ventilated Adults

- moderate to severe ARDS:
  The Panel recommends using a higher positive end-expiratory pressure (PEEP) strategy over a lower PEEP strategy (BIIa)

- refractory hypoxemia despite optimized ventilation, the Panel recommends prone ventilation for 12 to 16 hours per day over no prone
  ventilation (BIIa)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