

## Respiratory support for hospitalised COVID-19 patients

### Version 5 – what’s new?

- Expanded and enhanced sections on high flow nasal cannula oxygen (HFNO) and self-proning.

- i** Supplemental oxygen remains the mainstay of therapy for most hospitalised patients. Target  $SpO_2 \geq 90\%$  in non-pregnant adults, titrating to reach targets by means of a nasal cannula, simple face mask or face mask with reservoir bag.
- i** The use of the prone position in non-intubated, conscious patients who are hypoxaemic may be beneficial.
- i** Patients who have respiratory failure despite maximal facemask oxygen should be promptly identified and evaluated for possible escalation of respiratory support. Possible modalities include high flow nasal cannula oxygen, continuous positive airway pressure, or intubation and mechanical ventilation.

### General principles

#### Give supplemental oxygen therapy immediately to patients with low oxygen saturation.<sup>1</sup>

- Oxygen therapy is likely to be the single most effective supportive measure in COVID-19 patients. Target  $SpO_2 \geq 90\%$  in non-pregnant adults and  $SpO_2 \geq 92\%$  in pregnant patients.<sup>1</sup> Children with emergency signs (obstructed or absent breathing, severe respiratory distress, central cyanosis, shock, coma or convulsions) should receive oxygen therapy during resuscitation to target  $SpO_2 \geq 94\%$ ; otherwise, the target  $SpO_2$  is  $\geq 92\%$ .
- Titrate oxygen therapy up and down to reach targets by means of a nasal cannula, simple face mask or face mask with reservoir bag, as appropriate. Nasal cannulae should not be reused. Face masks and reservoir bags must be heat disinfected between each patient use if they are used for more than one patient.

		
O <sub>2</sub> dose 1–5 L/min	O <sub>2</sub> dose 6–10 L/min	O <sub>2</sub> dose 10–15 L/min
FiO <sub>2</sub> estimate 0.25–0.40	FiO <sub>2</sub> estimate 0.40– 0.60	FiO <sub>2</sub> estimate 0.60–0.95
Nasal cannula	Simple face mask	Face mask with reservoir bag

For paediatric oxygen recommendations, see section 5.1

#### Judicious fluid management in patients with COVID-19 is needed.

Patients who are relatively hypovolaemic (e.g. due to prolonged high fever), will need appropriate fluid replacement. However, overly aggressive fluid resuscitation may worsen oxygenation. This may be especially problematic in settings where there is limited availability of mechanical ventilation, and in patients with established ARDS.<sup>2,3</sup>

**Recognize severe hypoxemic respiratory failure when a patient with respiratory distress is failing standard oxygen therapy.** Patients may continue to have increased work of breathing or hypoxemia (SpO<sub>2</sub> <90%, PaO<sub>2</sub> <60 mmHg [ $<8.0$  kPa]) even when oxygen is delivered via a face mask with reservoir bag. Hypoxemic respiratory failure in ARDS commonly results from intrapulmonary ventilation-perfusion mismatch or shunt and usually requires mechanical ventilation.

In the absence of an indication for endotracheal intubation, a trial of high-flow nasal oxygen (HFNO), continuous positive airway pressure (CPAP) or other non-invasive ventilation (NIV) technique may be considered for adults with COVID-19 and acute hypoxaemic respiratory failure failing standard oxygen therapy.

- Patients receiving HFNO, CPAP or other NIV should be in a closely monitored setting and cared for by experienced personnel capable of endotracheal intubation if the patient acutely deteriorates. Intubation should not be delayed in such circumstances.

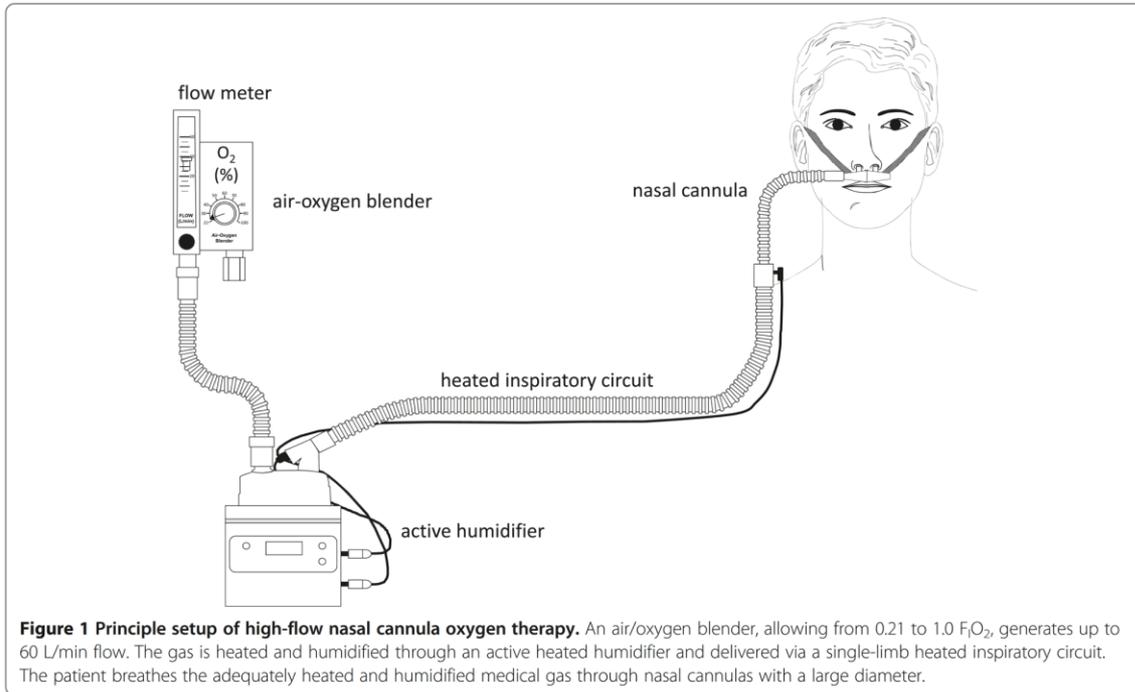
## High-flow nasal cannula oxygen (HFNO) therapy

### Background

Patients with COVID-19 pneumonia present with hypoxaemia of varying degrees. The cornerstone for the management of the hypoxaemia is the application of oxygen therapy via a variety of delivery methods. The value of high-flow nasal cannula (HFNC) oxygen therapy has been demonstrated in non-COVID-19 situations.<sup>4, 5</sup> Consequently, its value in the management of patients with COVID-19 pneumonia has been explored with a potential for improved outcomes.<sup>6-8</sup>

### Device

High-flow nasal cannula (HFNC) oxygen therapy is a technique configured to deliver adequately heated and humidified medical gas at a high flow rate. The device consists of a flow generator (providing gas flow rates up to 60L/min), an air-oxygen blender (that reliably achieves escalation of F<sub>i</sub>O<sub>2</sub> from 0.21-1.0 at user selected flow rates), and a humidifier that humidifies the gas mixture at temperatures of between 31-37°C (adjusted to patient comfort). To minimize condensation, the heated humidified gas is delivered via heated tubing through nasal prongs or cannula. The device is demonstrated in Figure 1.



From: Nishimura M. et al.<sup>4</sup>

### Advantages

HFNC is considered to have a number of physiological effects including:

- low levels of positive end-expiratory pressure (PEEP), at best up to 10 cm H<sub>2</sub>O, that may assist in increasing lung volume and recruitment of alveoli<sup>9, 10</sup>
- reduction of anatomical dead space as the high flow washes out CO<sub>2</sub><sup>11</sup>
- maintenance of a constant F<sub>i</sub>O<sub>2</sub> as the difference between inspiratory flow and delivered flow is small<sup>12</sup>
- humidification contributing to good muco-ciliary function and patient comfort,<sup>13</sup>
- decreased work of breathing<sup>14</sup>

Other general advantages in COVID-19 patients include that it:

- may be implemented and managed by non-ICU specialists outside ICU
- does not require invasive monitoring
- does not need as intensive nursing care as for invasive ventilation
- can be combined with awake self-proning
- may be a lower-resource alternative to mechanical ventilation in some patient
- Is relatively well tolerated and not too cumbersome allowing patient self-care or assisted care while applying the therapy, including daily functions such as eating.

### Concerns

*Is there an increased risk of transmission?*

The two main concerns relate to the risk of aerosolization and the adequacy of oxygen supplies. All respiratory therapy has the potential to create aerosols. A caution with HFNC initially arose because of a concern for possible generation of droplets and aerosols created or propelled by oxygen therapy via this delivery system with a consequent increased risk of disease transmission. Dispersion studies have shown that, compared to oxygen therapy with a mask or standard nasal cannulae at 5 L/min, the utilization of HFNC is no riskier with respect to either dispersion or microbiological contamination into

the environment.<sup>15,16</sup> The risk may be further mitigated by the additional application of, for example, a surgical mask to the patient.

#### *How do we ensure adequate oxygen supplies?*

As high flows (up to 60L/min) are used with HFNC systems, a concern rose on the adequacy of hospital oxygen supplies if the therapy was applied to a large number of patients within the same facility. The high flow of oxygen exceeds the requirements for routine general ward beds (4-15L/min), and for ICU or ventilated patients (30L/min).<sup>17</sup> This concern relates to storage and delivery of oxygen and questions the ability of banks or storage tanks for liquid oxygen to cope with demand in maintaining a constant flow and pressure to reticulation and supply points. Medical engineering consultation is required about oxygen supply at individual hospitals including number of HFNC units that can be supported.

#### **Indications**

For patients who are deteriorating or not improving on conventional oxygen therapy and supportive care, but who do not appear to be in imminent danger of collapse, HFNC oxygen therapy likely offers benefit. Consider HFNC in awake, co-operative patient if SpO<sub>2</sub> <92% despite FiO<sub>2</sub> of 1.0 at 15L/min.

Initiation of HFNC does not by default imply that a patient's care will be escalated to invasive ventilation. Certain patient groups will be reasonably triaged to receive HFNC as their last escalated oxygen therapy intervention. These decisions should be made in accordance with local facility triage team protocols as well as national guidelines (e.g. the CCSSA triage guidelines).

#### **Contraindications**

- Patients with hypercapnia (exacerbation of obstructive lung disease), haemodynamic instability, multiorgan failure or abnormal mental status should generally not receive HFNC oxygen therapy in place of other options such as invasive ventilation.
- Adults with emergency signs (obstructed or absent breathing, severe respiratory distress, central cyanosis, shock, coma and/or convulsions) should receive emergency airway management (e.g. endotracheal intubation) and O<sub>2</sub> therapy (e.g. via mechanical ventilation) during resuscitation to target SpO<sub>2</sub> ≥ 94% instead of HFNC.<sup>18</sup>

#### **Use**

- Discuss early with ICU team to ascertain limits of treatment levels at presentation in order to avoid inappropriate escalation of ventilatory support.
- Ideally HFNC O<sub>2</sub> therapy should be applied in single negative pressure rooms. If unavailable, then cohorting of patients requiring HFNC in designated wards is an alternative. Ensure adequate environmental ventilation of at least 12 air changes per hour, equivalent to a room with door and windows open or suitable extraction or air conditioner to achieve same, or with HEPA (high efficiency particulate air) filtration if recirculated air.
- Personal protective equipment (PPE), including N95/ FFP2 respirators, to be worn by the staff to reduce nosocomial infections.
- Ensure proper size and fit of nasal cannula. Most interfaces come with a lanyard and two clips to secure the piping to the hospital gown or pillow. If not, tape to the cheeks so prongs do not leave the nostrils.
- A surgical face mask may be placed on the patient at all times to further mitigate the risk of bioaerosolisation, with the masks being replaced when soiled.

- Effective HFNC may rely on patient being able to keep their mouth closed and maintain nasal breathing to ensure best performance of the device as mouth opening decreases the PEEP effect. Patients should be provided with clear information and educated about the treatment to achieve best results.
- Patients should be monitored with continuous pulse oximetry to enable monitoring of response and for early identification of rapid deterioration.
- Initial settings: Flow 50-60L/min and  $F_iO_2$  0.8-1.0, titrated to aim initially for  $SpO_2 >90\%$  are recommended.
- Particularly where hospital supply is constrained, be vigilant about using the minimum  $O_2$  flow necessary to maintain  $SpO_2$ . Titrate  $F_iO_2$  to 1.0 prior to increasing flow greater than 35L/min.
- Patients receiving a trial of HFNC should be in a monitored setting and cared for by personnel experienced with HFNC and capable of performing endotracheal intubation in case the patient acutely deteriorates or does not improve after a short trial (about 1 hour).
- Once HFNC has been initiated, need to assess the patient regularly and as clinically indicated to determine if the patient needs to be intubated.
- There should be a low threshold for intubation where there is clinical decline (which may include a rising  $O_2$  requirement, consistently or rapid increase in respiratory rate, consistently or rapidly declining  $SpO_2$ , increased work of breathing/exhaustion, and altered mental state). Intubation should not be delayed if the patient acutely deteriorates or does not improve after a short trial (1 hour).
- Initiation of HFNC does not by default imply that a patient's care will be escalated to invasive ventilation. Although some patients may proceed to invasive ventilation, many will not with These decisions should be made in accordance with local facility triage team protocols as well as national guidelines. If resources and staffing allow, HFNC may still be a reasonable intervention in patients who do not meet local facility triage team protocols as well as national guidelines criteria for ICU admission. In this situation, it may represent the limit of care.
- If the target  $SpO_2$  is achieved and the patient is clinically improving (decrease in respiratory rate and respiratory distress), weaning should be commenced. Flow may be gradually reduced by 5-10 L/min and  $F_iO_2$  by 0.05-0.1 every 2-4 hours. Switching to conventional  $O_2$  therapy should be considered when  $F_iO_2 < 0.4$  and flow  $< 20$  L/min.

## Mechanical ventilation

Patients with hypoxaemic respiratory failure may require intubation and mechanical ventilatory support. Detailed recommendations on ventilation strategies are beyond the scope of this guideline. Always consult an intensivist if possible, or alternatively a practitioner experienced with mechanical ventilation. Nonetheless, the general principles to consider include:

- Individualise ventilatory strategies based on respiratory mechanics and disease progression.
- Use lung-protective ventilation strategies for patients with established ARDS who have low lung compliance.
- Aim for an initial tidal volume of 4-6ml/kg.<sup>19</sup> Higher tidal volume up to 8 ml/kg predicted body weight may be needed if minute ventilation requirements are not met in a patient with good lung compliance.
- Strive to achieve the lowest plateau pressure possible. Plateau pressures above 30 cmH<sub>2</sub>O are associated with an increased risk of pulmonary injury.<sup>19</sup>
- Hypercapnia is permitted if meeting the pH goal of >7.15-7.20.
- Application of prone ventilation 12-16 hours a day is strongly recommended for patients with severe ARDS.<sup>19</sup>
- In patients with moderate or severe ARDS, identifying optimal PEEP levels will require titration of PEEP.<sup>19</sup>
- The use of deep sedation may be required to control respiratory drive, achieve tidal volume targets, and assist with patient-ventilator dyssynchrony.
- In patients with moderate-severe ARDS (PaO<sub>2</sub>/FiO<sub>2</sub> <200), neuromuscular blockade by continuous infusion should not be routinely used.<sup>20</sup> Continuous neuromuscular blockade may still be considered in patients with ARDS in certain situations: ventilator dyssynchrony despite sedation, such that tidal volume limitation cannot be reliably achieved; or refractory hypoxemia.
- Avoid disconnecting the patient from the ventilator, which results in loss of PEEP and atelectasis. Use closed system catheters for airway suctioning and clamp endotracheal tube when disconnection is required (for example, transfer to a transport ventilator). A high efficiency particulate filter on the expiratory limb of the ventilator circuit should be used.

## Self-proning

Prone positioning has been shown to improve oxygenation in spontaneously breathing, non-intubated non-COVID-19 patients with hypoxemic acute respiratory failure.<sup>21</sup> Consequently, its potential value in the management of patients with COVID-19 pneumonia has been explored.<sup>22, 23</sup> A management strategy involving early intervention and awake proning with high-flow nasal cannula or non-invasive mechanical ventilation to prevent alveolar collapse resulted in lower intubation and mortality rates than observed in other locations.<sup>24</sup> Other studies have demonstrated that application of self-proning with HFNC may help avoid intubation.<sup>25, 26</sup>

### Physiological effects of proning

The physiological benefits of prone positioning that should apply to all patients regardless of whether they are intubated or not, include:

- Improved Ventilation/Perfusion (VQ) matching and reduced hypoxaemia (secondary to more homogeneous aeration of lung and ameliorating the ventral-dorsal trans-pulmonary pressure gradient – more uniform lung ventilation, better distribution of air flow and better matching of areas that receive oxygen and appropriate blood flow.)
- Reduced shunt (perfusion pattern remaining relatively constant while lung aeration becomes more homogenous – better matching of areas that have blood flow to receiving oxygen)
- Recruitment of the posterior lung segments due to reversal of atelectasis;
- Improved secretion clearance.

### **Different approaches to positional adjustment in COVID-19**

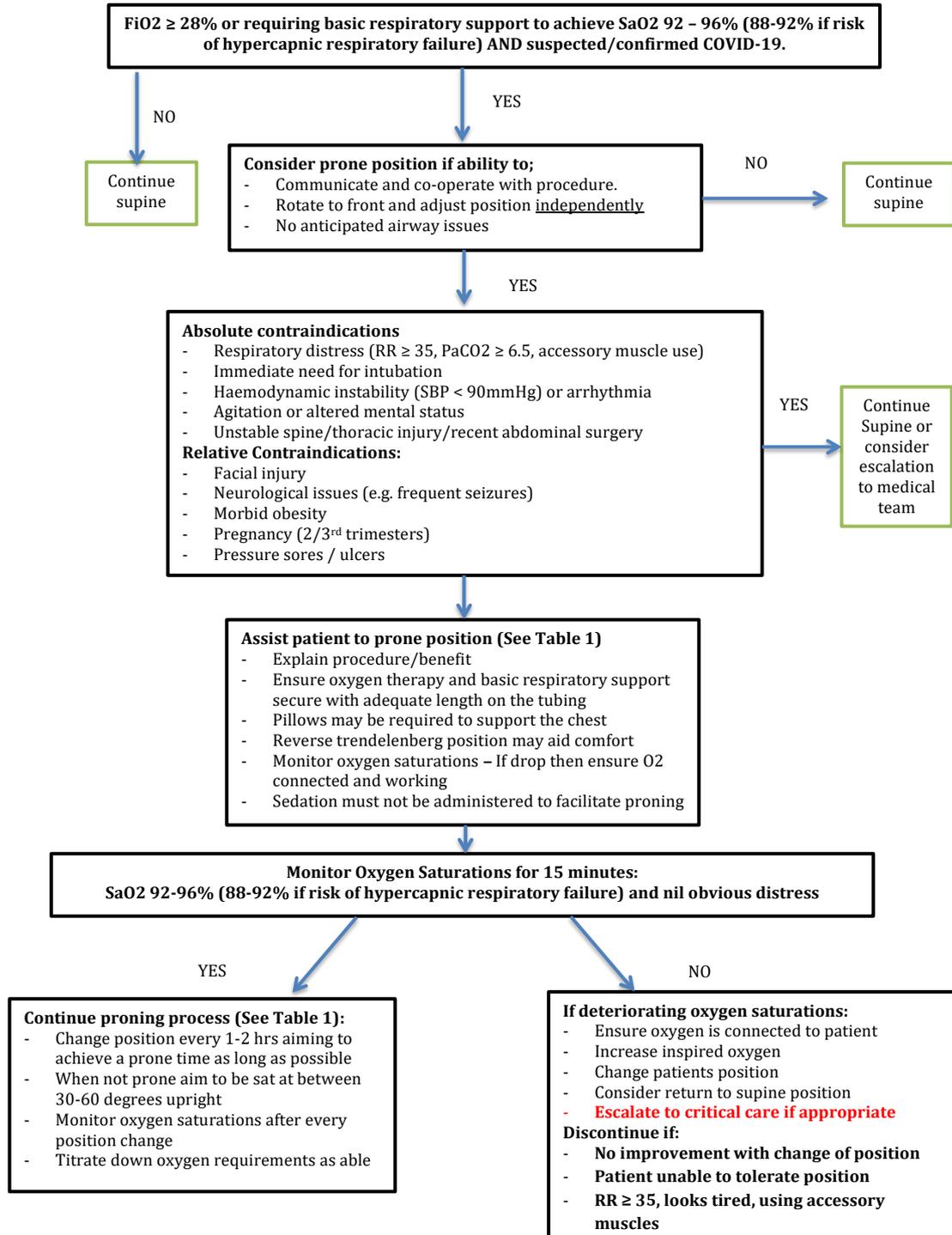
Various approaches have been attempted.

- Complete pronation (with the patient lying on their abdomen, ideally for ~16-18 hours per day) as in proned intubated patients would be optimal. However, this can be difficult in many patients e.g. with obesity.
- Another approach is to rotate positions, including lying on either side and sitting bolt upright which may be easier for many patients to tolerate.
- Some centres encourage mobilization via walking of selected COVID-19 patients.
- Proning for a few hours with a return to supine position may lead only to transient improvements in oxygenation. Longer-lasting benefit might result from longer periods of pronation, or strategies involving ongoing rotation between several different positions. The key principle is to avoid spending much time in a flat, supine position.

As one suggested approach, we suggest following the UK Intensive Care Society's proning recommendations as outlined below.<sup>27</sup>

Awake pronation appears to be a safe, inexpensive, and versatile strategy which can be used at all levels across a variety of different healthcare settings.

**Figure 1 – Flow diagram decision tool for Conscious Proning process**



**Table 1 – Timed position changes for patients undergoing conscious proning process**

**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.....

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