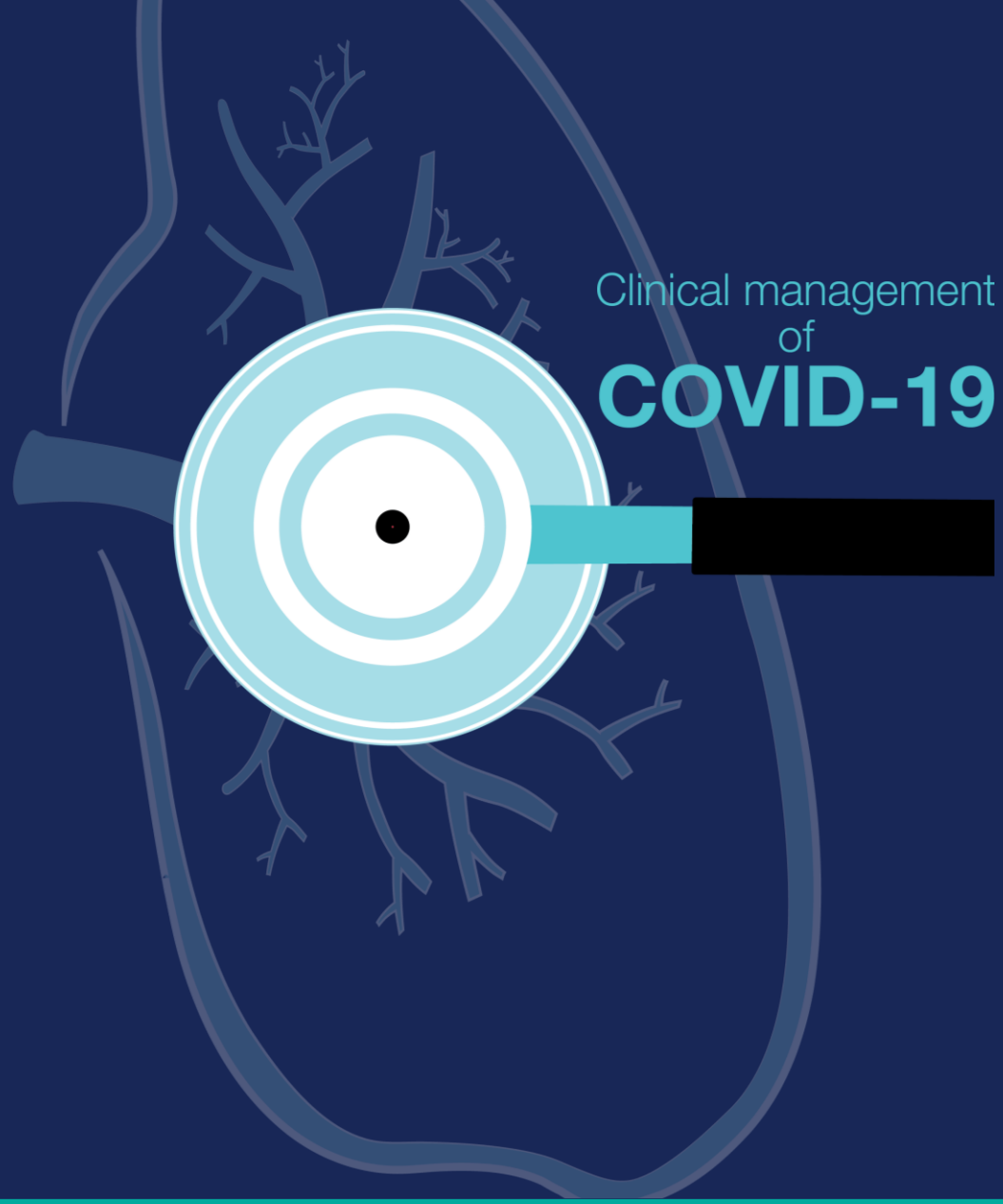
Management of critical COVID-19

Advanced non-invasive respiratory support:
high-flow nasal oxygen and non-invasive ventilation

Part 2: NIPPV High-flow nasal oxygen (HFNO)



World Health Organization

HEALTH EMERGENCIES programme

Disclaimers

- This presentation is not intended to and cannot replace a formal critical care curriculum or training.
- Content in this presentation is for illustrative purposes only.
- Decisions regarding the use of any respiratory support modality must be made by a licensed provider and take into account each patient's specific clinical history and other circumstances; and be in accordance with relevant local guidelines and protocols, and appropriate maintenance to ensure quality and safe performance.
- Any respiratory support device should be managed with a multidisciplinary support team whenever possible, which might include doctor(s), nurse(s), respiratory therapist(s) and other technician(s), depending on jurisdictional context.
- Any respiratory support device should receive appropriate maintenance to ensure quality and safe performance.

Learning objectives

- Describe how to initiate, monitor and titrate HFNO.

Characteristics of high-flow nasal cannula (HFNO)

- Delivered through a comfortable nasal cannula interface. May be better tolerated than NIPPV.
- Able to provide high airflow rates (up to 60 L/min in adult).
- FiO_2 is controlled through the total flow rate of gas administrated to the device. Therefore, its directly linked to the gas source and flowmeter control.
- Higher airflow rates can provide a low level of positive end expiratory pressure (PEEP).
- The airflow is warmed and humidified to prevent dryness.
- Provides washout of dead space in the upper airways which may improve ventilation.

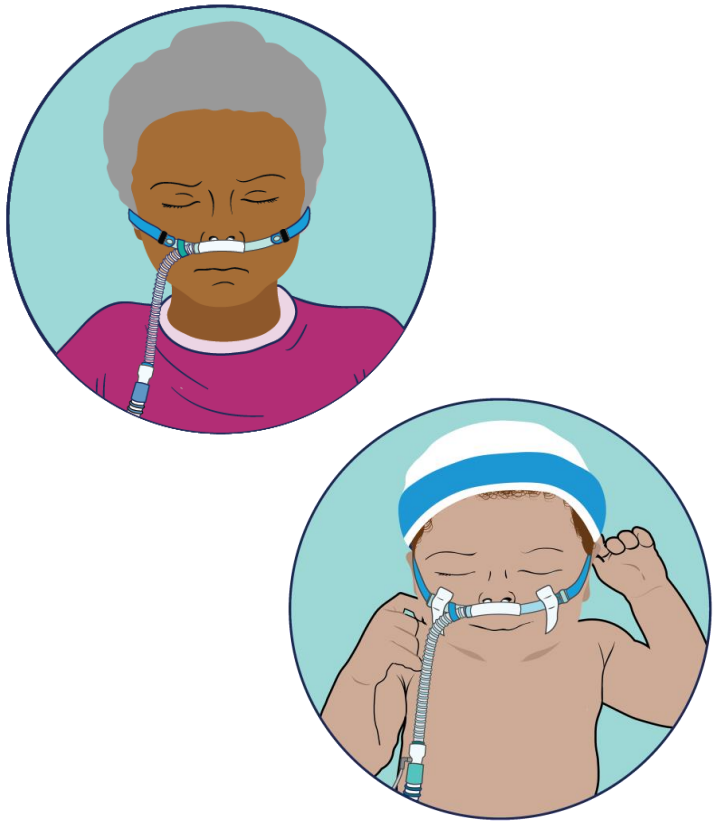
Selecting the right size nasal cannula for HFNO

General tips:

- Select the best size of high-flow nasal cannula, according to manufacturer instructions.
- Ensure correctly fitting nasal cannula for the patient.

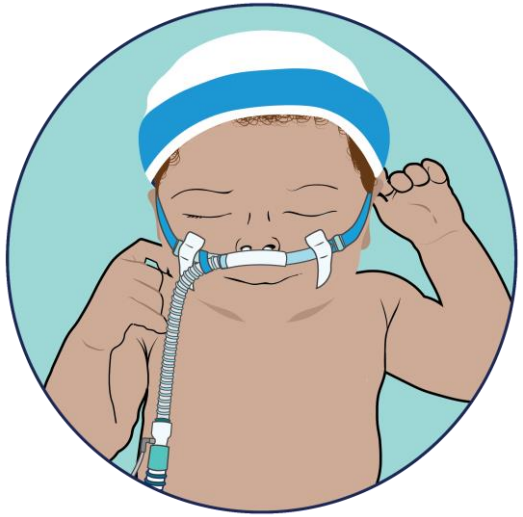
In children:

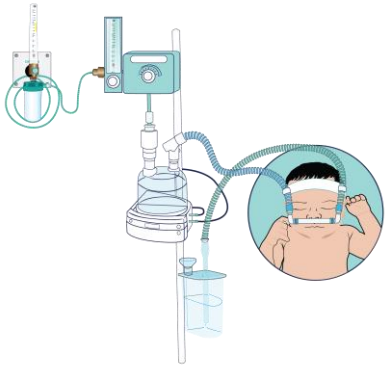
- Interface size should not exceed 50% of the size of nares.
- When the flow is above 25 L/min change to adult interface.



Heated humidification and flow dials

HFNO





Initiating and titrating high-flow nasal oxygen (HFNO) in adults

Adults:

Initiate device airflow rate at 40 L/min flow (for adults and children > 15 years) and oxygen flowmeter at highest to deliver 100% FiO_2.

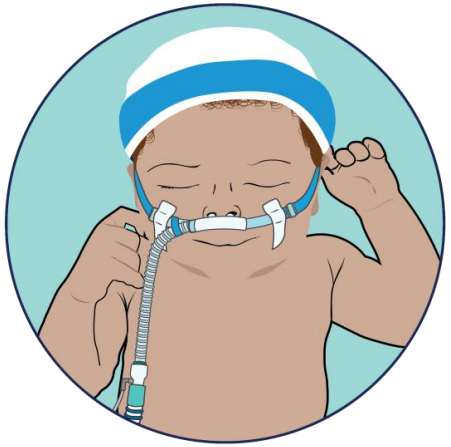
Titrate the flow up or down to target clinical response (maximum is 60 L/min):

- patient comfort
- improved work of breathing
- reduced RR
- stable haemodynamics and mental status.

To avoid overuse of oxygen supply it is extremely important to the oxygen flowmeter (FiO_2) down to use the lowest FiO_2 necessary to achieve target:

- SpO_2 ≥ 90% for adults and children, 94% ≥ for pregnant patients and 94% ≥ for children with signs of multi-organ dysfunction.

Initiating and titrating high-flow nasal oxygen (HFNO) in children



Select target airflow rate based on age and weight:

0–10 kg --> 2 L/kg/min

10–20 kg --> 1 L/kg/min

20–40 kg --> 0.5–1.0 L/kg/min (max 30 L/min).

Initiate airflow rate at 50% of target and FiO_2 at 60%.

Increase flow gradually (every 5 minutes) to achieve **good patient response** and not to exceed target flow rate.

Titrate the oxygen flowmeter (FiO_2) down to use the lowest FiO_2 necessary to achieve target $SpO_2 \geq 90\%$.

This is extremely important – to avoid overuse of oxygen supply and minimal adverse effects to the patient.

Rationale use of oxygen and airflow with HFNO

Use the lowest airflow rates and FiO_2 necessary to achieve patient comfort and SpO_2, respectively.

When airflow is adjusted, FiO_2 needs to be checked as it may change with flow adjustment due to the entrainment of room air:

- For example, higher airflows may reduce FiO_2 and thus require oxygen flowmeter to be increased.
- Conversely, lower flow rates may increase FiO_2 and thus require reduction in oxygen flow rate (FiO_2).

Troubleshooting

For patients on HFNO with persistent hypoxaemia or respiratory distress:

- Check the **equipment:** inspect the exterior of the machine, the tubing (circuit), the prong for any sign of mechanical damage, confirm it fits and the filters are in place. Ensure the settings are appropriate and flow is maximized.
- Check the **oxygen source:** there is sufficient oxygen available and flowing through the device. If FiO_2 > 50% of oxygen is needed, the device must have a blender.
- Check there is no **obstruction with secretions:** patients with COVID-19 may have very thick secretions which may block small and large airways and cause sudden respiratory deterioration.

Avoid strategies which may dry secretions (e.g. high flow dry O_2/air).

Ensure adequate **secretion clearance** and consider failure to clear secretions as a trigger to abandon advanced non-invasive respiratory support and proceed to intubation and invasive mechanical ventilation.

Do not delay intubation if the patient is worsening on a short trial (1 hour) of advanced non-invasive respiratory support or has any urgent indication for intubation.

Indications to prepare for intubation and invasive mechanical ventilation (IMV)

Despite appropriate titration of HFNO if patient shows any urgent indication for intubation or fails to show improvement, then proceed to airway management, intubation and invasive mechanical ventilation.

RED FLAGS:

- Severe signs of respiratory distress, such as consistently elevated respiratory rate for > **60 min trial**: **≥ 60 bpm** if < 2 months; **≥ 50 bpm** in 2–11 months; **≥ 40 bpm** if 1–5 years; **≥ 30 bpm** in adults and children > 5 years.
- Severe hypoxaemia, such as P/F < 100.
- Apnoea or periodic breathing (unstable drive).
- Hypoventilation:
  - increase in $PaCO_2$ ≥ 10 mmHg or 1.3 kPa
  - respiratory rate < 8/min.
- Severe agitation, acute change in mental status, diaphoresis, patient discomfort.
- Haemodynamic instability (signs of shock).

Ferrer S, Sancho J, Bocigas I, et al. ROX index as predictor of high flow nasal cannula therapy success in acute respiratory failure due to SARS-CoV-2. Respir Med. 2021;189:106638. doi:10.1016/j.rmed.2021.106638 https://rc.rcjournal.com/content/65/9/1276

Summary

- Advanced non-invasive respiratory support (HFNO) may reduce the need for intubation and mortality in COVID-19 patients with acute hypoxaemic respiratory distress not requiring emergent intubation.
- Good candidates are **awake, alert and cooperative**.
- Advanced non-invasive respiratory support (HFNO) is a risk for aerosol generation and use with **airborne precautions.**
- Keys to success with these modalities include **early initiation**, **close monitoring** by **experienced health workers,** and **frequent adjustment** of oxygen flow and/or pressures as needed for beneficial clinical response.

Do not delay intubation if the patient is worsening on a short trial (1 hour) of advanced non-invasive respiratory support or has any urgent indication for intubation.

Resources

COVID-19 clinical management: living guidance. https://www.who.int/publications/i/item/clinical-management-of-covid-19

IMAI district clinician manual: hospital care for adolescents and adults: guidelines for the management of illnesses with limited resources. https://www.who.int/publications/i/item/imai-district-clinician-manual-hospital-care-adolescents-and-adults

Oxygen therapy for children: a manual for health workers. https://www.who.int/maternal_child_adolescent/documents/child-oxygen-therapy/en/

WHO-UNICEF technical specifications and guidance for oxygen therapy devices. 2019. https://www.who.int/publications/i/item/9789241516914

Technical specifications for invasive and non-invasive ventilators for COVID-19 https://www.who.int/publications/i/item/technical-specifications-for-invasive-and-non-invasive-ventilaotrs-for-covid-19

WHO COVID-19 technical guidance: essential resource planning. https://www.who.int/emergencies/diseases/novel-coronavirus-2019/technical-guidance/covid-19-critical-items

WHO: Oxygen sources and distribution for COVID-19 treatment centres. 4 April 2020. https://www.who.int/publications/i/item/oxygen-sources-and-distribution-for-covid-19-treatment-centres

Transmission of SARS-CoV-2: implications for infection prevention precautions (who.int) https://www.who.int/news-room/commentaries/detail/transmission-of-sars-cov-2-implications-for-infection-prevention-precautions

Oxygen sources and distribution for COVID-19 treatment centres https://www.who.int/publications/i/item/oxygen-sources-and-distribution-for-covid-19-treatment-centres

Clinical care of severe acute respiratory infections – Tool kit https://www.who.int/publications/i/item/clinical-care-of-severe-acute-respiratory-infections-tool-kit

Agarwal A, Basmaji J, Muttalib F, Granton D, Chaudhuri D, et al. [High-flow nasal cannula for acute hypoxemic respiratory failure in patients with COVID-19: systematic reviews of effectiveness and its risks of aerosolization, dispersion, and infection transmission.] Can J Anaesthesia. 2020;67(9):1217-1248. https://doi.org/10.1007/s12630-020-01740-2

Christi MJ, Salam MA, Smith JH, Ahmed T, Pietroni MA, et al. Bubble continuous positive airway pressure for children with severe pneumonia and hypoxaemia in Bangladesh: an open, randomized controlled trial. Lancet. 2020;386(9998):1057-65. https://doi.org/10.1016/S0140-6736(15)60249-5

Lissauer T, Duke T, Mellor K, Molyneux L. Nasal CPAP for neonatal respiratory support in low and middle-income countries. Arch Dis Child Fetal Neonatal Ed. 2017;102(3):F194-F196. https://doi.org/10.1136/archdischild-2016-311653

Myers S, Dinga P, Anderson M, Schubert C, Mlotha R, et al. Use of bubble continuous positive airway pressure (bCPAP) in the management of critically ill children in a Malawian paediatric unit: an observational study. BMJ Open Respiratory Research. 2019;6:e000280. https://doi.org/10.1136/bmjresp-2018-000280

Navas-Blanc JR, Dudaryk R. Management of respiratory distress syndrome due to COVID-19 infection. BMC Anesthesiol. 2020;20(1):177. https://doi.org/10.1186/s12871-020-01095-7

Sun Q, Qiu H, Huang M, Yang Y. Lower mortality of COVID-19 by early recognition and intervention: experience from Jiangsu Province. Ann Intensive Care. 2020;10(1):33. https://doi.org/10.1186/s13613-020-00650-2.

Jardine L, Davies MW. Withdrawal of neonatal continuous positive airway pressure: current practice in Australia. Pediatr Int. 2008;50(4):572-575. doi:10.1111/j.1442-200X.2008.02617.x

Acknowledgements

Contributors

Dr Paula Lister, Great Ormond Street Hospital, London, UK

Dr Neill Adhikari, Sunnybrook Health Sciences Centre, Toronto, Canada

Dr Janet Diaz, WHO, Geneva, Switzerland

Dr Wilson Were, WHO, Geneva, Switzerland

Dr Pryanka Relan, WHO, Geneva, Switzerland

Dr Jacobus Preller, WHO, Geneva, Switzerland

Dr Marta Lado, WHO, Geneva, Switzerland

Dr Bharath Kumar Tirupakuzhi Vijayaraghavan, Consultant, WHO

Dr John Adabie Appiah, Consultant, WHO